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Engineering
News-Record

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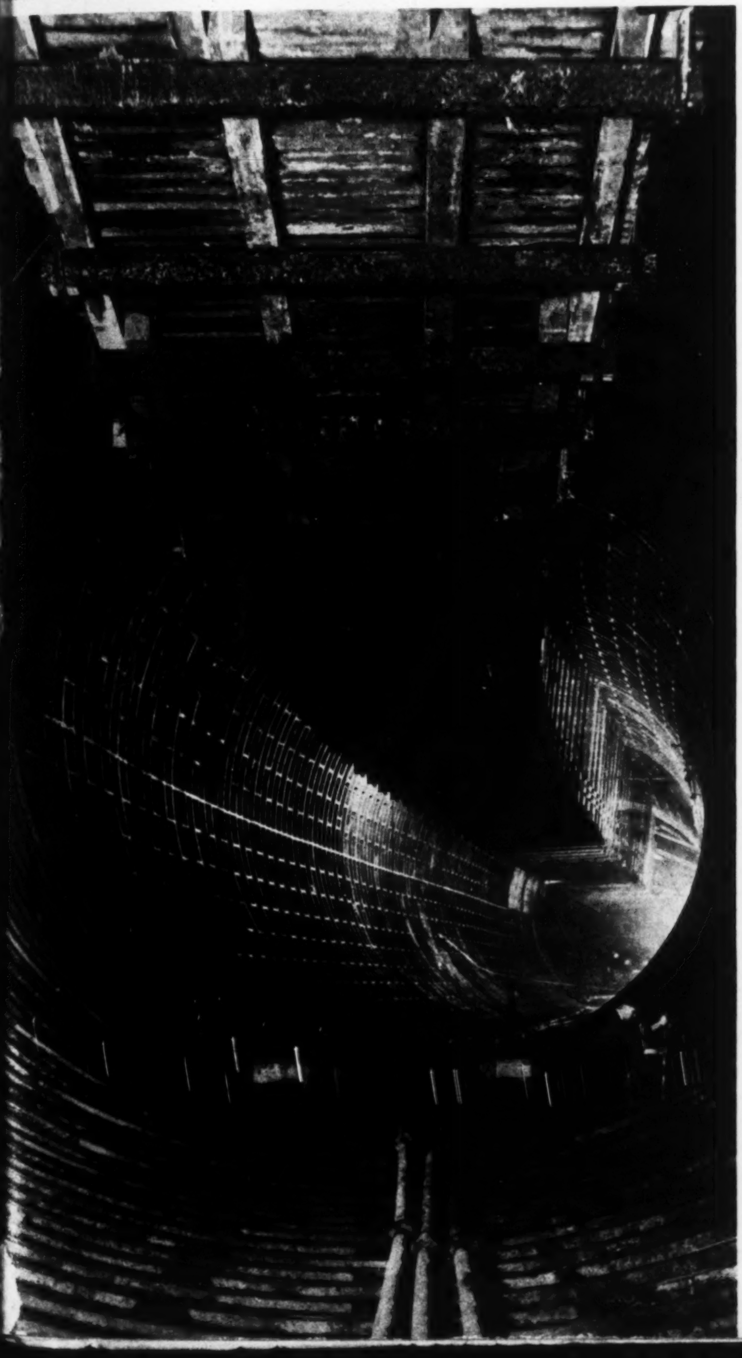
November 16, 1933

t-iron lining of the 44-ft. diameter vehicle tunnel under the Mersey River at Liver-
l, England. This tunnel will have a 36-ft. roadway for four lanes of traffic. The
rhead bridge in the view leads to the scene of pilot-heading excavation operations.



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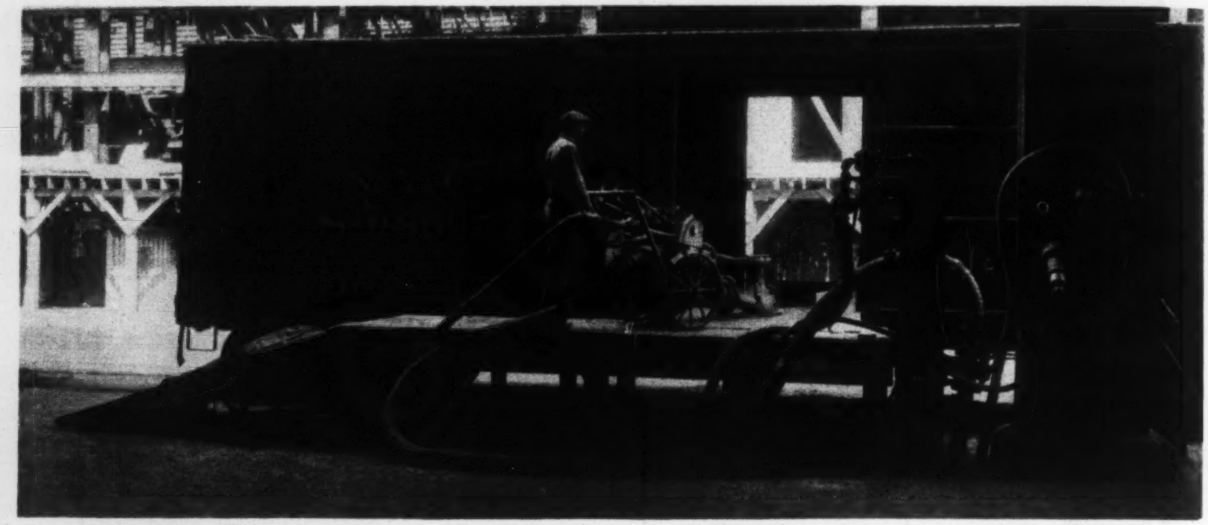

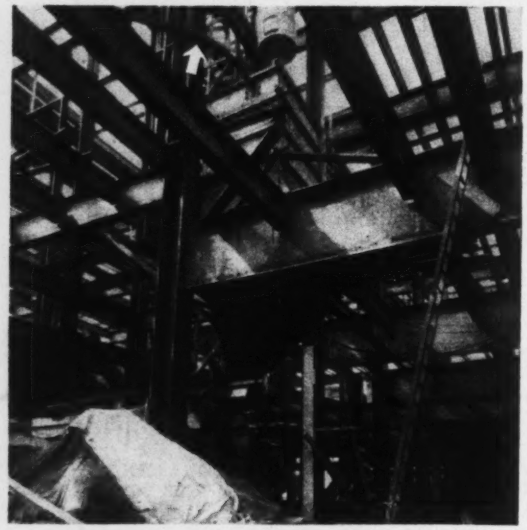

The portable Fuller-Kinyon Pump shown above is unloading cement for the construction of the St. Johns Park Freight Terminal of the New York Central Railroad. The cement is pumped to two mixing plants in different parts of the building. The conveying distance to each plant is in excess of 400 feet. One of the mixing plants was moved to a new location as the work progressed. Approximately 82,000 barrels of cement will be required.

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One of the mixer bins on the present job is shown at the left, the cement transport line being indicated by the arrow.

A remotely controlled, fully automatic Fuller Cement Batcher withdraws cement from this bin. This is the second job for this batcher. Another Fuller Automatic Batcher, of newer design, is used at the other plant.

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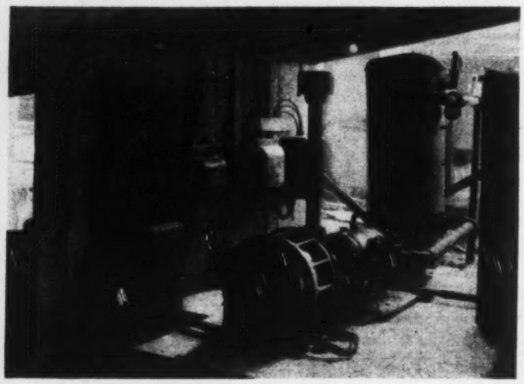

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Mersey River Vehicle Tunnel in England Nears Completion

Tunnel connecting Liverpool and Birkenhead, 44 ft. in internal diameter, will have a 36-ft. roadway for two lanes of traffic in each direction—Shield tunneling employed for a distance of 1,100 ft.

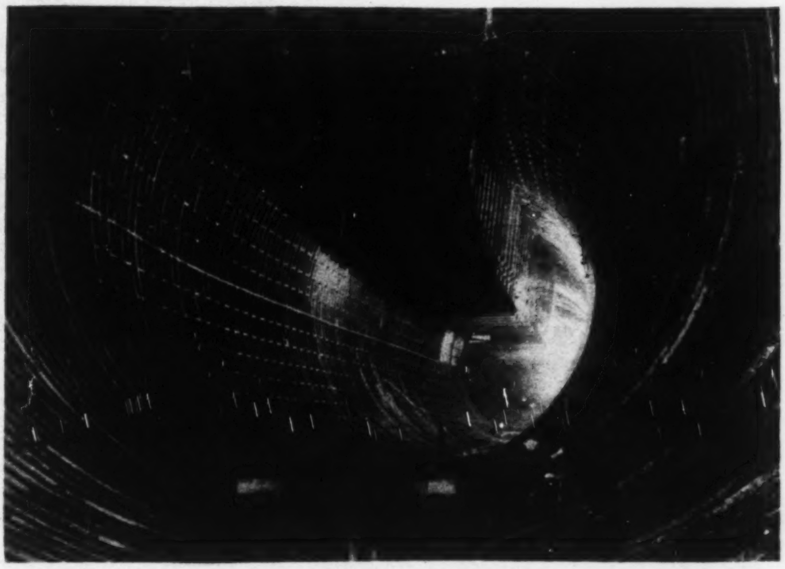
By E. E. R. Tratman
Formerly Western Editor, Engineering News-Record

A SUBMARINE highway tunnel, 2.13 miles long and 44 ft. in internal diameter under the Mersey River, in England, has been built to improve communication between Liverpool and Birkenhead, and also to connect extensive highway systems which at present are separated by the river. The two towns, of 1,000,000 and 150,000 population, respectively, are on opposite sides of the river, but hitherto have been connected only by ferry steamers and the tunnel of the Mersey Railway, a local electric line. The main part of the new vehicle tunnel is complete, but some of the auxiliary works remain to be completed, and it is expected that the new route will be opened to traffic early in the summer of 1934.

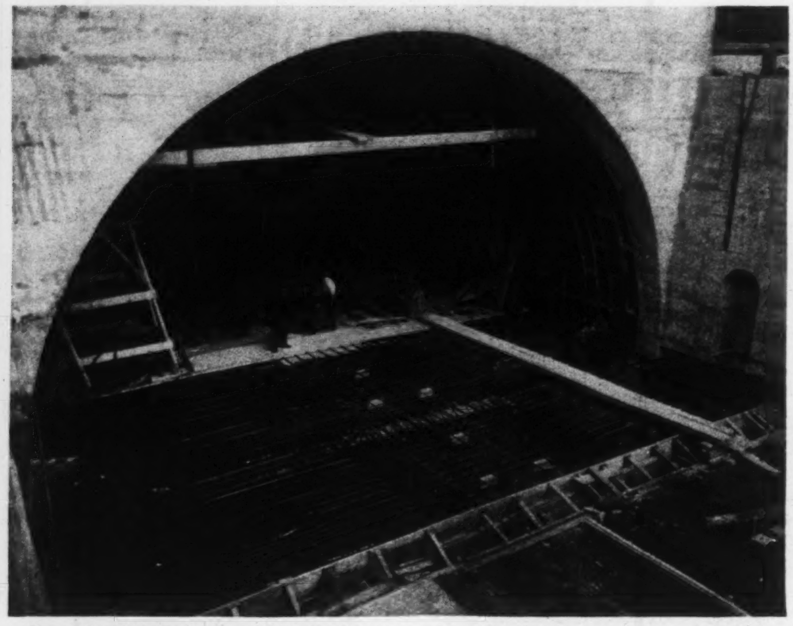
In view of the growing necessity for improved cross-river transportation facilities, a committee of engineers was appointed in 1922 to consider the relative advantages of a bridge and a tunnel. Its report was unanimously in favor of the latter. In 1925 government approval was given by the passage of a law which also established the Mersey Tunnel Joint Committee, to be composed of members appointed by the respective towns.

The under-river part of the tunnel, 5,274 ft., or about a mile in length, is of circular section, 46 ft. 3 in. in outside diameter and 44 ft. clear diameter inside the lining. It is in a fissured and water-bearing sandstone formation and has a lining of cast-iron segments filled with concrete on the inside. A reinforced-concrete deck or floor, 18 in. below the horizontal diameter, provides a 36-ft. four-lane roadway and two 4-ft. sidewalks for the use of the patrolmen and tunnel staff. Two partition walls supporting this deck form a large central compartment for pipe lines or for some special form of transportation that may be developed in the future while the two side areas are for the fresh-air supply to the tunnel.

Between the land shafts the Mersey Tunnel is 46 ft. 3 in. in outside diameter. The exterior shell is of cast iron and concrete.



In the main parts of the approaches on each side of the river, the tunnel is practically semicircular in section, with an invert about 7½ ft. deep below the roadway slab. In these main approach tunnels the roadway width is 36 ft. On each side of the river there is a dockside branch approach, consisting of a horshoe tunnel 26½ ft. in inside diameter, with a 19-ft. roadway for two lanes of traffic. In both the main and dockside approach



Haymarket portal in Liverpool, showing the heavily reinforced roadway slab over the sump.

or subterranean tunnels the entire invert space below the deck slab forms the conduit for the fresh-air supply.

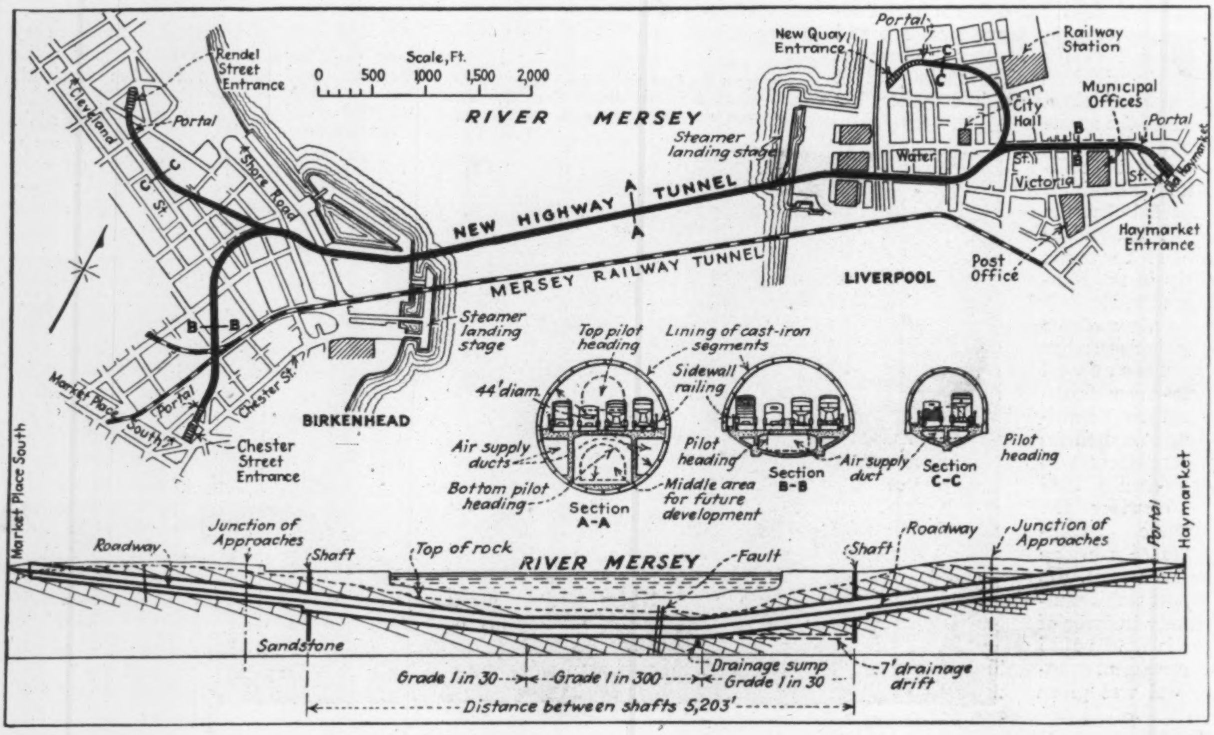
The four open-cut approaches aggregate about ¼ mile, making the total length of roadway about 2.87 miles including the auxiliary or dockside branches. On the direct route the length between main entrances is 2.13 miles, while between the dockside entrances the distance is 2.08 miles.

From the Liverpool entrance the roadway has a grade of 3.33 per cent to the lowest point of the tunnel, about 150 ft. below high water in the river and with 60 ft. of cover over the crown of the tunnel. Beyond this point the grade rises at 0.33 per cent for 1,670 ft. and is then at 3.33 per cent to the Birkenhead portal. Part of the Birkenhead dockside branch has a grade of 2. per cent.

From two shafts about a mile apart and 200 ft. deep, pilot headings were driven under the river and were completed before the enlargement to full tunnel section was started. These headings were about 15x12 ft.

For the land or semicircular sections there was a single heading on each side, with its bottom at the invert level. For the full circular section, there were top and bottom pilot headings. Work on the shafts was begun in February and March, 1926. The top headings under the river met in April, 1928, with a divergence of only ⅝ in. in line, ½ in. in level and 1 in. in length. Enlargement to full section and placing of the cast-iron lining was then begun at several points.

A shield advanced by hydraulic jacks was used for a length of 1,100 ft. at the Liverpool approach, where the top of the tunnel was in clay and came so near the surface as to necessitate support for a street. In the 44-ft. circular section the upper part was first excavated to full size and then lined, after which the lower half was completed in the same way. Where the tunneling work was above the groundwater level but was still below the rock surface, the lining consisted of steel I-beams spaced about 2½ ft. apart and embedded in the concrete. Streets crossing the Birkenhead approach made it necessary to use a flat roof of plate girders and concrete



Plan of the Mersey Tunnel. Longitudinal section along the center line of the tunnel and main approaches, also cross-sections of the main tunnel and dockside approach roadways.

Rendel Street Entrance
Scale, Ft.
0
500
1,000
1,500
2,000
RIVER MERSEY
Cleveland St.
Portal
C
C
Shore Road
NEW HIGHWAY TUNNEL
A
A
MERSEY RAILWAY TUNNEL
Steamer landing stage
B
B
Market Place South
Portal
Chester St.
BIRKENHEAD
Chester Street Entrance
New Quay Entrance
Portal
C
C
Railway Station
Municipal Offices
City Hall
Water St.
Victoria St.
B
B
Portal
Haymarket
Haymarket Entrance
Post Office
LIVERPOOL
Steamer landing stage
Top pilot heading
Lining of cast-iron segments
Sidewall railing
44' diam.
Air supply ducts
Bottom pilot heading
Section A-A
Middle area for future development
Pilot heading
Section B-B
Air supply duct
Section C-C
Pilot heading
Market Place South
Roadway
Junction of Approaches
Shaft
Top of rock
RIVER MERSEY
Fault
Shaft
Roadway
Junction of Approaches
Portal
Haymarket
Sandstone
Drainage sump
7' drainage drift
Grade 1 in 30
Grade 1 in 300
Grade 1 in 30
Distance between shafts 5,203'

supported on side walls at each crossing.

As a great deal of water was encountered in the rock, a separate drainage drift or heading, 7 ft. in diameter, was driven below the level of the tunnel on the Liverpool side and leading on a grade of 0.20 per cent from under the lowest point of the tunnel to the Liverpool working shaft, whence the water was pumped to a high-leved storm sewer.

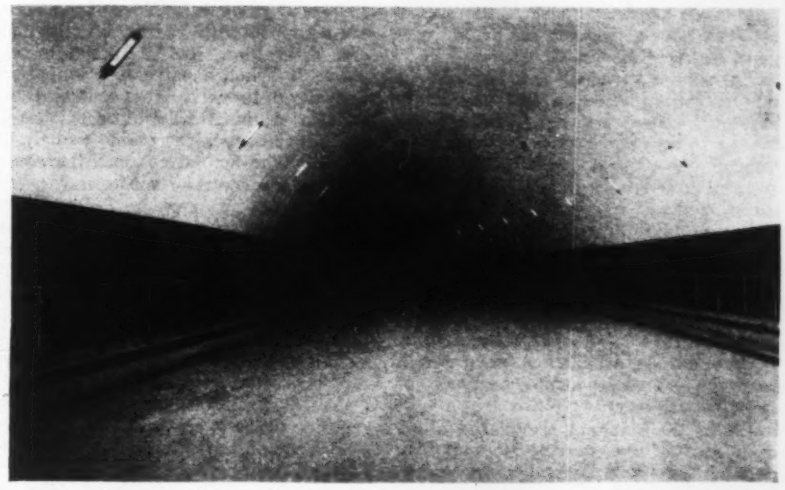
Special care was taken to make the tunnel watertight, in order to avoid high cost of maintenance and pumping. For this purpose, external grouting was applied at pressures up to 120 lb. through holes in the cast-iron segments of the lining. Further, all joints in this lining were calked with lead, and bituminous gaskets were fitted on all the bolts. As a result of this care there was very little seepage and the lining was quite dry before the inner filling of concrete was applied.

As each length of enlargement and lining was completed, work was commenced on the reinforced-concrete deck. Above the deck level the iron lining was faced with concrete and the sidewalks were built, with conduits in them for the electric cables and wires. A cement gun then placed a ¾-in. reinforced facing on the concrete; this was followed by the spraying of a bituminous composition, then a cream-colored gypsum plaster, and finally the spraying of a transparent varnish as a finishing coat. This type of facing stops at 7 ft. above the sidewalks. Below that point is a facing of black glass in panels outlined by strips of stainless steel. A hand-rail along the curb provides protection for men using the walks.

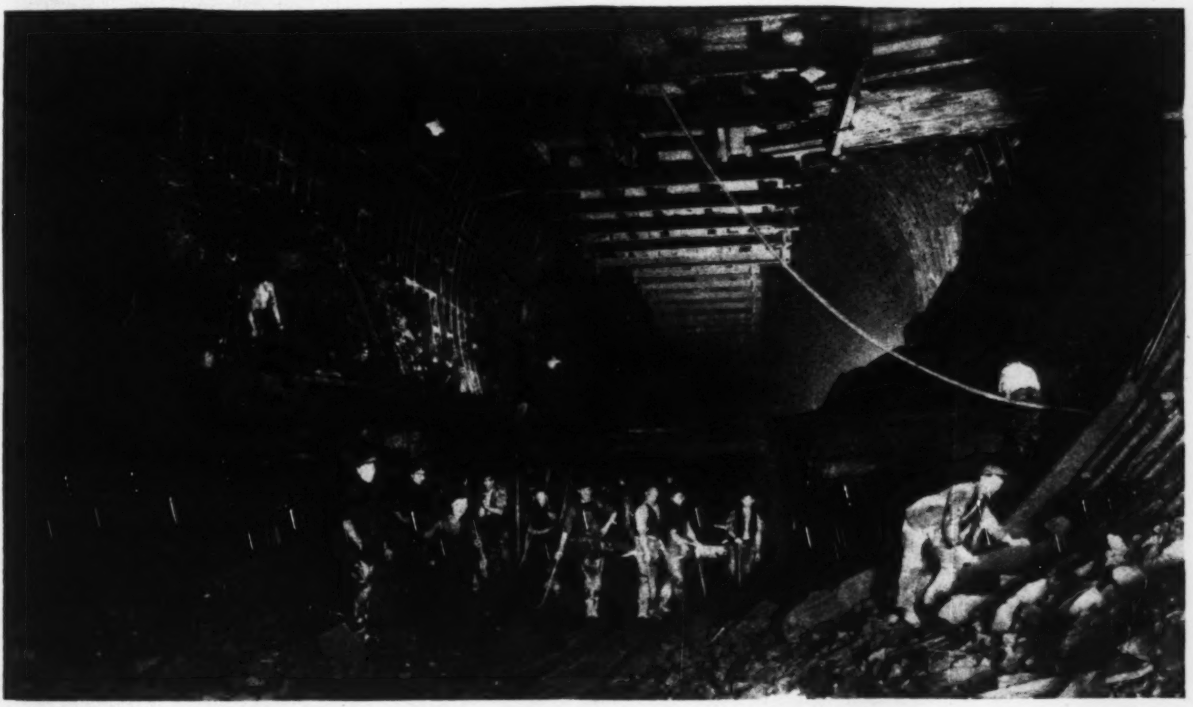
Stone masonry is used to face the concrete retaining walls along the open-cut approaches.

A roadway paving of cast-iron blocks, 12x12 in. and 2 in. deep, is laid on the concrete deck slab, the blocks being bedded in and grouted with a bituminous composition. The traffic lanes are outlined by the insertion of amber-colored blocks of rubber, alternating with the cast-iron blocks.

Ventilation is provided by six fan plants, three on each side of the river. Fresh air forced into the ducts under the floor escapes through ports 18 in. apart into a continuous expansion chamber having a slotted opening along the face of the concrete curb. Fouled air and gases flow along the roof space of the tunnel, and are drawn out by exhaust fans at each ventilating station. The largest fans have impellers 28 ft. in diameter and a capacity of 641,000 cu.ft. per minute. For the smallest fans the capacity is 92,000 cu.ft. per minute. Each fan will be driven by a two-speed electric motor and reducing gear, with a



Roadway deck of the Mersey River Tunnel, 36 ft. wide, before the cast-iron paving had been laid. Along the walkways the walls are faced with black glass; above is a cream-colored gypsum plaster with a gloss finish.



Top and bottom headings were driven under the river from the land shafts, and, when complete, enlargement and lining was begun at several points. In the view here shown only a short section of the bottom heading remains. The suspended bridge overhead extends to enlargements of the upper pilot heading.

hydraulic coupling between the motor and the gear to provide further adjustment of speed.

At each station all the plant is in duplicate to provide against any interruption of the service. With all the fans working at maximum output, a volume of 2,500,000 cu.ft. of fresh air per minute can be delivered to the tunnel and an equal volume of foul air removed. By these means the proportion of carbon monoxide should never exceed 2½ parts per 10,000 parts of air under normal conditions, or 4 parts under extreme peak loads. Electric current will be supplied by the municipal power stations of the two towns, each having two independent sources of supply.

Lights 20 ft. apart are placed along each side of the tunnel, staggered in position on opposite sides. Alternate lights are fed from alternate circuits. For further security every tenth light at each end is fed from a plant at the opposite end of the tunnel. Near the portals the spacing of the lights is decreased gradually, so as to accustom drivers to the change from outside to interior lighting.

Fire stations 150 ft. apart and staggered on opposite sides of the tunnel are equipped with hydrants, extinguishers, sand bins, fire alarms and telephones. When a patrolman sounds the fire alarm to notify the control room, it also automatically operates traffic signals at convenient points to halt the traffic. The man telephones the conditions to the control-room operator, who then notifies the municipal fire departments if necessary. Signs at these fire stations warn drivers that if traffic is halted, they must stop their engines and so prevent the emission of noxious or dangerous gases. On each side of the river an emergency exit is provided in case it should be necessary to get people out of the tunnel quickly.

Sir Basil Mott, of the consulting engineering firm of Mott, Hay & Anderson, London, is the engineer responsible to the Mersey Tunnel Joint Committee, and with him is associated John A. Brodie, formerly city engineer of Liverpool; B. H. M. Hewett is engineer in charge; B. H. Colquhoun is resident engineer.

The contractors for the shafts, tunnel work and approaches were Edmund Nuttall, Sons & Co., Manchester, and Sir Robert McAlpine & Sons, London.

Channel Regulation for the Mississippi

Discussion of bed load, bank erosion, cutoffs and branch closure as involved in the new plans for Mississippi flood control

By P. Claxton

Executive Engineer, Indus Canals Division, Dera Ghazi Khan, Punjab, India

THE NEW PLAN for stabilizing the Mississippi River as summarized in *Engineering News-Record*, June 22, 1933, suggests a number of considerations developed by experience on the rivers of India. A statement of the investigations and conclusions of the river engineers as presented in the article referred to are summarized here.

It has been recognized that erosion and deposition by the river have been correlated to the amount of sediment that it holds in suspension.

In the new studies, however, special attention was attracted to the character and amount of bed load and its movements, and it was realized that the bed load was likely to prove a determinative element in the hydraulics of the river.

Field observations showed that there is a large volume of bed load, that it is in intermittent movement, and that it consists of coarse material of bars and tow heads. It was also indicated that its movement is related to flow velocity.

Two important conclusions emerged from the investigation: (1) The transporting power of the water is a function of depth. (2) The bed load moves in small jumps, and some jumps are across and not along the current. From this it was argued that detritus tends to move away from the filaments of highest velocity toward the regions of low velocity.

This conclusion has been checked mainly by observations of deposit and bar formation in the various model river-channel experiments at Vicksburg, and is supposed to have far-reaching relation to the entire complex of river problems Extensive field work in sampling bed-load material to determine its amount and character is being carried out in conjunction with observations where the material is deposited, and ought to contribute valuable data.

One of the tentative conclusions of the commission engineers is that the reaction between the flowing water and the moving bed load not only determines where deposits are formed but also the points of erosion attack of the water. This reaction is supposed to be the initial cause of the tendency of a straight reach to meander. By control of the movement of bed load the engineers hope to be able to reduce the instability of the stream.

The observation that the heavy detritus tends to move away from the filaments of highest velocity can by no means deplete the main stream of its heavier load of detritus. The broad result remains that the heaviest deposits are always to be found along the course of the main stream.

The moving away of the detritus from the filaments of highest velocity is a minor local effect confined to the sides of the main stream and is doubtless due to the differences of pressure head.

As the detritus moves into the filaments of lower velocity, deposition is also heavier because the power of transportation is immediately lowered. This tendency evinces itself eventually in the characteristic margin which gives elevation at the lip of overflow with a falling away of the land surface on either side.

The tendency ought also to choke the formation or continuance of subsidiary branch streams. The commission has found that in certain instances this is not the case; and although the main stream appears to push the detritus out of its way into these side branches, some of them still continue and persist. They have traced this to the geometrical form of the point of the island as governing the turbulence and cross-currents at the division of flow. Tests of particular cases by models have shown that modifying this point through a dike carried upstream will cause the detritus to go into the minor channel.

They hope to utilize this automatic filling of chutes or branches both as a means of eliminating divided channel conditions and as a means of getting detritus out of the river in order to prevent its deposition downstream and the resulting tendency of the river to attack its banks.

Consideration of bed load

Now in these conclusions the commission has confined itself to bed load and has entirely omitted bank erosion. After an experience of more than twenty years on the rivers of the Punjab, the writer has found that it is bank erosion more than bed load that accounts for river movements.

There may be a difference in the terrain through which the Punjab rivers flow. Here it is made up largely of detritus which at one time or another was itself the load of the river. From the opening remarks this is partly also the condition on the Mississippi, for it is stated that "The bed load consists of coarse material identical with the raw material of bars and tow heads." If the relative conditions are at all similar, I have no hesitation in concluding that bank erosion on the Mississippi will have effects proportionate in result to bank erosion of rivers in the Punjab.

I feel confident in predicting that the Mississippi River Commission engineers will find that they cannot ignore bank erosion as a governing factor of river formation.

Restating the general action briefly: for some reason the stream is deflected into a bank and commences to erode it. The detritus adds to this load, the quantity increasing down the eroding bank until it is too great for the stream to transport. It then begins to show itself as a bar that has a turning force capable of carrying the stream round till it impinges into the opposite bank. Thus the natural swing of the river is established and continued.

All this has already been discussed with the Vicksburg experimenters themselves, and they support my opposition to the theory of helicoidal flow around a bend. I refer to correspondence ending with a letter of May 19, 1932, from G. Bebout to Lieut. H. D. Vogel, director of the experimental station at Vicksburg. In this letter Mr. Bebout says that his observations on the Mississippi and Red rivers show that bar-building material is not transported by the helicoidal flow theory across the channel from a caving bend to the bar opposite.

Importance of bank erosion

If not transported to the opposite bar, erosion and bar-building on the same side must be related as cause and effect. That is why the reaction of the bar is so real, for while bank erosion is the cause higher up, bar-building, the effect, must develop lower down. Its turning power is enormous, and time and time again this has been demonstrated in convincing and remarkable results, which leave no doubt that bank erosion plays a leading part in determining the course of the river.

Yet the Mississippi commission ignores bank erosion and is accepting conclusions based on the reaction of flowing water and the bed load only. By this they hope to show that such reaction not only determines where deposits are formed but also the points of erosion attack. They argue that this reaction is the initial cause of the tendency of a straight reach to meander.

By considering bank erosion, the cause lies in the excess of detritus which the stream is called on to carry. Cause and effect are so correlated that the result, once started, is bound to continue, and the stream cannot help but meander.

Take an example on any loop on the Mississippi itself. What power could carry the stream round into loops so difficult? If the bank erosion were not a factor to be reckoned with, no possible force could deflect the normal flow into such fantastic shapes. The other conceivable force—i.e., reaction between the flowing water and the moving bed load—is too weak to consider, but if it does afford an initial cause, it can give no explanation for itself in growing into an almost irresistible force that will bend the stream into such tortuous loops. Whatever the initial cause, bank erosion has the power of giving this growing power in the bar, which it continues to create so long as it is active. Bed detritus may be an added initial cause by raising a bar capable of deflecting flow, but having done this it is quite incapable of continuing the work. From this we are forced to the conclusion that the main cause for streams meandering is attributable to bank erosion. The causes that start bank erosion may be many and slight, but it would appear that fluctuations in volume of flow are the most prolific. By such fluctuations the bank must fall in, but owing to differences in soil and irregularities too numerous to mention such falling in is never regular. Its irregularity is enough to start deflections that develop into bank erosion.

By considering the effect of bank erosion, some explanation of why certain branch channels do not fill up may be given; admitting that the main stream has a tendency to push away detritus to the sides, branch channels should all the more readily be choked at offtake. Bank erosion, however, introduces loads that may easily defeat this result. For instance, should the main stream have an eroding bank opposite and slightly above the branch, the resulting detritus might be erecting a bar across the main stream and be pushing its water directly into the branch. I have known such a bar created by erosion to push the main stream out of its more direct course into the branch itself.

Many other causes also may be present, but if we look for bank erosion some explanation will be forthcoming.

Cutoff problems

In addition to these causes, there is a natural disadvantage under which the branch labors. Anyone who has had experience in closing a branch will know that it is easiest to do so at the very offtake. A point even 500 ft. lower down will create velocities much more violent while contraction by closure proceeds. The reasons for this are beyond the scope of this article, but they certainly indicate that the branch has more reasons than one for being choked.

There ought, therefore, to be no great difficulty for the river commission in inducing the branch to choke itself. A few permeable jetties disposed as dikes, as suggested by the commission, at the nose of the island or if possible right across the branch at the offtake, should be enough.

But more than the choking of these branches, the commision proposes to straighten the main stream by cutoffs at bends so long opposed as disastrous expedients. The question arises whether the straight reaches thus introduced will continue to remain straight or develop other loops as troublesome as the first.

The proposals involve methods by which it is hoped loops will be prevented from forming, and the object of the investigation is to show on what lines this may be done. The commission has approached the problem by proposing to control the amount of bed load by getting it out of the main stream into the branches.

While the choking of the branches may temporarily rob the main stream of some detritus, it cannot continue to draw off the load for an indefinite time. While also the regimen of the main stream may be permanently improved by having branches choked, the problem of preventing more loops from forming is not solved.

In fact we must accept the certainty that meandering will reassert itself in reaches that have been straightened out. A remedy that is prepared to meet this condition is the only one that can hope to be successful.

The commission, in addition to the remedy alluded to above, contemplates revetment, and it is believed that for ultimate stabilization half the length of either bank must be revetted.

The cost of revetment of articulated concrete slabs ranges from $250,000 to $500,000 per mile, and its life is limited. Search for more effective and cheaper types of protection is being made.

Proposed plan

In India we should not for a moment consider revetment. For this reason engineers have had to seek a system of protection without revetment.

In previous articles in *Engineering News-Record* such a system has been suggested. After striving to express the river meanderings as a fixed law in an article published Aug. 18, 1927, the writer attempted to show how such meanderings might be controlled by the formation of still-water pockets, in an article published Oct. 17, 1929. After discussion of the position of the river in 1904, the Plum Point Reach was used to show how, by dikes forming still-water pockets, its position of 1902 might have been stabilized.

By such a process the meanderings of a river, while allowed scope to develop, might be so controlled as to bring the stream back to its original position. The still-water pockets, in other words, limit each development, and, by forcing the stream into loops, effect natural cutoffs and restore original conditions.

It would appear that some such method of control will be needed after the river has been straightened. Or if the existing condition of the river is desirable, stillwater pocket control is yet needed to keep it there.

There may be objections to this form of control, but if there are, they have to be stated. When they are, it will be time to enter into them and to find needed modifications.

Five Years' Operation of Milwaukee Sewage Plant

General observations and detailed performance figures on the operation of an 85-m.g.d. activated-sludge plant, including costs of operation and maintenance

PERFORMANCE figures for one of the country's earliest, as well as one of the most important, activated-sludge sewage-treatment plants became available for the first time on Sept. 26, 1933, when five years of continuous operation of the plant at Milwaukee, Wis., were reported on in detail by Darwin W. Townsend, principal assistant engineer of the Milwaukee Sewerage Commission, before the annual meeting of the American Society of Municipal Engineers. In his paper, of which the present article is an abstract, Mr. Townsend made available complete operating data on the activated-sludge process itself, in addition to cost and performance figures on the processes used to convert waste sludge into fertilizer.

While the Milwaukee sewage-treatment plant has been in operation since June, 1925, the five-year period selected for report extended from Jan. 1, 1928, to Jan. 1, 1933, during which operation was continuous. Plant operation prior to 1928 was somewhat irregular, owing to the necessity of performing a great deal of preliminary work and of organizing and training the personnel.

Sewage treatment at Milwaukee

The sewage-treatment processes employed at the Milwaukee plant can be described briefly as follows: Activated-sludge treatment is preceded by coarse and fine screening and grit-chamber treatment. The activated-sludge plant itself consists of 24 reverse-flow aeration tanks and 15 side-flow sedimentation tanks. The aeration tanks are 236 ft. long, 44 ft. wide, and 15 ft. deep. The ridge and furrow system of aeration is employed throughout. Of the sedimentation tanks, 11 are 98 ft. square by 15 ft. deep, and four are 42 ft. square by 15 ft. deep. The excess or waste sludge is dewatered by vacuum filters and by indirect-heat rotary dryers, and is converted into a fertilizer known as "Milorganite." Sewage screenings and grit are disposed of by incineration, following partial dewatering in centrifugal machines.

The sewage is, for the greater part, collected in a system of combined sewers serving the Metropolitan Sewerage District, an area including the major part of Milwaukee County. The sewage flow from this area approximates 110 m.g.d., but from 25 to 30 m.g.d. of this amount cannot be treated in the existing plant because of inadequate capacity. Additional capacity will be provided by the construction program now in progress.

A strong industrial sewage prevails, as can be seen from the B.O.D. shown in Table I. These analyses have been based on 24-hour composite samples taken following the screen and grit-chamber treatment. Those preliminary processes, however, yielded, per m.g. of sewage, an average of 150 lb. of coarse screenings, with a moisture content of 88 per cent; 975 lb. of fine screenings, moisture content 92 per cent; and 325 lb. of grit, moisture content 55 per cent. These preliminary removals are equivalent to a total of 29 p.p.m. of suspended matter, which should be added to the screened-sewage figures to give the amount contained in the sewage as it enters the plant.

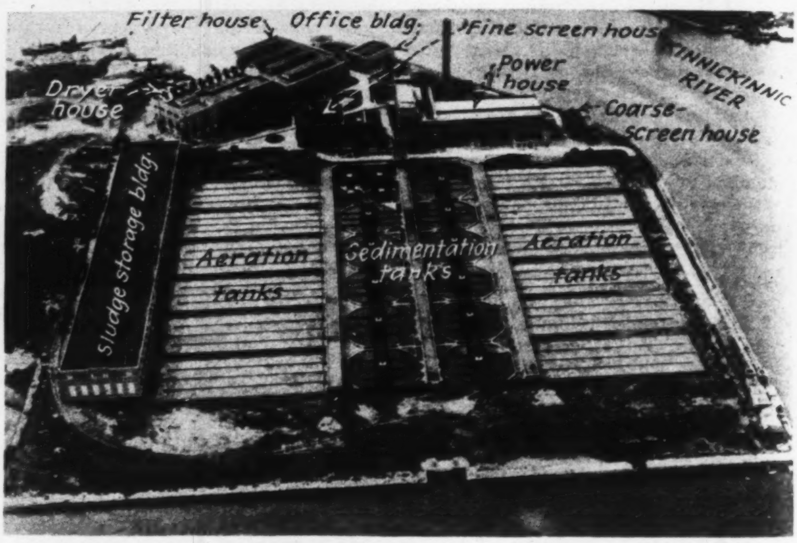


Fig. 1—Aerial view of the Milwaukee sewage-treatment plant, as it was during the period reported on. Additional aeration and sedimentation tanks are now being constructed on an extension of the plant site out into Lake Michigan.

Activated-sludge operation

While the effect of temperature upon various phases of the activated-sludge process is known in general, experience at the Milwaukee plant has indicated that accelerated rates of activity are conducive to accelerated rates of sludge settling and solids concentration. Such increased activity was observed during the summer of 1932, when settled sludge containing solids to the extent of 6 to 7 per cent was formed on the bottom of the settling tanks. Under such conditions microscopic examination of activated-sludge floc revealed the presence of abnormally large numbers of filamentous growths among the usual micro-organisms present. At times the solids concentration was great enough to cause difficulties in removing it from the sedimentation tanks. When a similar condition occurred in June, 1933, the rapidity of settling and subsequent high concentration was checked by shortening the period of aeration.

It will be noted from Table I that about three-fourths of the total nitrogen content of the raw sewage can be accounted for in the plant effluent and in the Milorganite. Of the 40.6 p.p.m. in the raw sewage, the sedimentation-tank effluent accounts for 12.8 p.p.m. and the Milorganite for 17.7 p.p.m. (when figured on a raw-sewage basis).

It becomes periodically necessary in operation to take an aeration tank out of service for general cleaning or for conditioning diffuser plates. Out of the 24 aeration tanks in the Milwaukee plant, the record for the five-year period shows that an average of 22.5 tanks were in continuous service.

Figures given for aeration periods, Table I, refer only to the aeration taking place in the aeration tanks proper. As a matter of fact, aeration also occurs in the various supply channels, as they are also equipped with air-diffuser plates. The average aeration period in these channels for the five-year period was 1.26 hours, or about one-quarter of that in the aeration tanks. The figures for air consumption take into account the air used in these supply channels.

TABLE I—OPERATING DATA OF MILWAUKEE SEWAGE PLANT

	1928	1929	1930	1931	1932	Av. for 5 years
Raw Sewage						
Total flow, m.g.d.	81.8	85.1	77.2	79.4	79.0	80.5
Screened Sewage						
Total solids, p.p.m.	1,012	1,006	1,052	918	946	987
Suspended solids, p.p.m.	326	320	338	272	264	304
B.O.D., p.p.m.	271	257	278	275	269	270
20 deg. bacteria, thousands per c.c.	1,689	2,250	2,750	2,587	2,776	2,410
Temperature, deg. F	58	59	59	61	60	59.4
pH	7.2	7.2	7.1	7.4	7.4	7.3
Nitrogen (as NH_3), p.p.m	39.4	37.7	45.6	39.9	40.4	40.6
Return sludge						
Per cent of sewage flow	33.1	35.3	36.0	34.0	27.9	33.3
Suspended solids, per cent	1.01	1.13	1.05	1.23	1.37	1.16
Aeration tanks						
Mixed liquor, suspended solids, per cent	0.27	0.33	0.32	0.31	0.32	0.31
Aeration period, hours	4.64	5.03	5.46	5.61	5.96	5.34
Air used, cu.ft. per gal. sewage	1.35	1.38	1.54	1.61	1.63	1.50
Sedimentation tanks						
Sedimentation period, hours	2.36	2.17	2.32	2.33	2.45	2.30
Effluent						
Total solids, p.p.m	649	654	676	627	654	652
Suspended solids, p.p.m	18	17	16	20	21	18.4
B.O.D., p.p.m	11.8	8.8	9.4	14.9	14.6	11.9
20-deg. bacteria, thousands per c. c.	82	52	48	46	47	55
Nitrogen (as NH_3) p.p.m.	10.0	9.7	19.8	11.8	12.5	12.8
Nitrite, p.p.m	0.73	0.74	0.13	0.80	1.56	0.80
Nitrate, p.p.m	1.47	2.48	0.51	3.04	3.65	2.28
Stability, hours	105	105	86	99	86	96.1
Removals, screened sewage to plant effluent, per cent						
Suspended solids	93.9	94.6	94.8	92.3	91.8	93.5
20-deg. bacteria	96.1	97.2	97.8	98.0	98.0	97.5
B.O.D	95.5	96.6	96.7	94.3	93.9	95.4
Waste sludge						
Quantity, m.g.d.	1.42	1.26	1.49	1.59	1.54	1.46
Suspended solids, per cent	1.53	1.73	1.62	1.25	1.24	1.47
pH before conditioning	7.3	7.2	7.3	7.5	7.6	7.3
pH after conditioning	3.17	3.31	3.54	3.69	3.87	3.51
$FeCl_3$ (anhydrous) lb. per ton of Milorganite	....	91.2[1]	109.8[2]	159.3	143.7	....
H_2SO_4 (60-deg. B), lb. per ton of Milorganite	....	67.8[1]	97.6[1]	70.7[3]	.....	....
Sludge filters						
Yield, lb. per sq.ft. per day, dry basis	22.3	26.1	25.6	26.7	32.1	27.6
Filter-cake moisture, per cent	84.6	83.3	84.0	83.2	83.0	83.6
Sludge dryer						
Lb. of Milorganite per lb. of coal burned	1.19	1.41	1.38	1.50	1.49	1.39
Milorganite						
Quantity, ton per day	88.4	95.6	98.5	77.3	86.1	89.2
Moisture content, per cent	2.97	3.97	3.87	3.76	4.57	3.83
Nitrogen content (as NH_3) per cent	6.83	6.29	6.46	7.51	7.66	6.95
Ash content, per cent	30.5	33.5	32.9	26.6	23.8	29.5
Fats, per cent	6.08	6.08	6.46	5.89	5.64	6.03

[1] Average for five months. [2] Average for ten months. [3] Average for two months.

It has been the custom in operating this plant to maintain a suspended-solids content in the mixed liquor of about 3,000 p.p.m. This solids content, within reasonable working limits, has been found to give the best results for the general conditions encountered. The importance of plant balance, as far as mixed-liquor solids is concerned, is probably of greater significance at the Milwaukee plant than at activated-sludge plants where no practice is made of processing waste sludge. At Milwaukee it is highly important that the processing plant as well as the purification plant be maintained in constant working balance.

A study of the tabulated figures will reveal that the raw sewage was stronger (higher in B.O.D.) during the year 1930 than in any of the other years reported on, while during that year the amount of sewage treated was at its lowest point. That this smaller volume of stronger sewage was generally more resistant to treatment is evident from the lower stability, lower nitrite and nitrate content and higher total nitrogen of the plant effluent during 1930. On the other hand, the removal of suspended solids, bacteria and B.O.D., on a percentage basis, was somewhat higher in that year than during the other four. In explanation of this condition, it seems likely that the greater reduction of suspended solids in the year 1930 was a direct reflection of the lower sewage flow, and resulted in the improved performance in removing bacteria and B.O.D.

Sludge disposal

There are two stages in the sludge-dehydration process: vacuum filtration and heat drying.

Preliminary to the filtration process the pH of the waste sludge is adjusted to optimum filtration rates, these rates being predetermined each day in the laboratory upon a battery of Buechner vacuum funnels, the sludge in each test being diluted with distilled water to about 1 per cent of solids. While these laboratory observations are indicative of sludge filterability at the time they are made, frequent changes may be expected in optimum filtration rates through a 24-hour period, and frequent pH adjustments are therefore necessary.

Ferric chloride and sulphuric acid were used separately and in combination as the chemical reagents for pH adjustment during the first four years of the period reported, but since the beginning of 1932 ferric chloride only has been used. For the purpose of mixing the ferric chloride with the sludge, a 10-min. aeration period is employed. The conditioned sludge is pumped to the filter tanks through rubber-lined piping.

For the filtration process 24 continuous vacuum filters are provided, 12x14 ft. When the service of these filters is computed in terms of filter-hours, it is found that the average number of filters in use during the five years was 13.2; the greatest number of units in use during the day, when averaged over the five-year period, was 16.4; while maximum days necessitated the use of as many as 22.8 filters. The greater number of filters in use on maximum days was necessitated not by an increased quantity of waste sludge but by the more resistant filtering characteristics of the sludge.

The second stage of sludge dehydration is accomplished in rotary heat dryers. The coal used during the report period averaged 12,753 B.t.u. per pound. The average number of dryers in service during the five-year period was 5.06, this uneven number being obtained by averaging on a basis of dryer-hours. Obviously, it is necessary for efficient operation to vary the number of units in service to conform to the volume of sludge to be processed.

TABLE II—PERFORMANCE FIGURES OF INCINERATION PLANT NOV. 16, 1932, to SEPT. 1, 1933

	Average No. Tons Day	Moisture Content, Average Per Cent
Fine screenings	8.00	76.80
Coarse screenings	1.37	72.12
Grit	12.12	58.31
Milorganite dust	0.73	15.00
Total material incinerated	22.22	.....
Fuel oil consumed, gal	600	.....

Incineration of screenings and grit

The incineration plant for the disposal of screenings and grit is equipped with 20-ton-per-day, oil-fired, refractory-arch-type incinerator units and five horizontal centrifugal machines. This plant was placed in operation on Nov. 16, 1932. Since that time and up to Sept. 1, 1933, there had been burned a total of 3,492 tons of grit, 394 tons of coarse screenings, 2,303 tons of fine screenings and 211 tons of Milorganite dust from the dryer cyclone chambers. A total of 172,602 gal. of fuel oil was consumed in this work, the oil having an average content of 19,320 B.t.u. per pound.

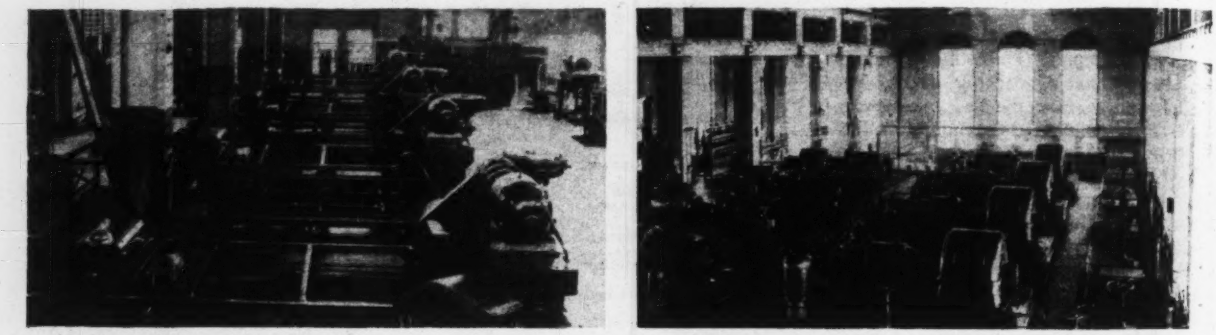
Prior to the instalation of the incinerator plant, screenings and grit were deposited upon a small area of land at the treatment site. While the period of incinerator operation has been relatively short, its performance has been quite satisfactory, particularly from the standpoint of unsightliness. There has been neither smoke nor odor.

Performance figures for the centrifuging and heat-drying processes are presented in the accompanying Table II.

TABLE III—COSTS OF OPERATION AND MAINTENANCE

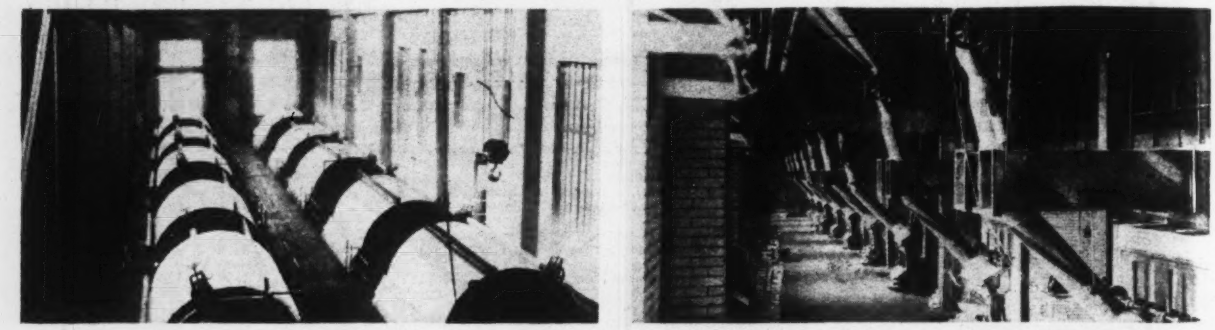
	1929	1930	1931	1932	Av. for 4 years
Cost of Milorganite production and marketing, per mg. sewage	$18.24	$20.60	$16.58	$17.07	$18.11
Revenue from sale of Milorganite per m.g. sewage	19.92	17.88	10.66	10.17	14.65
Net cost of sludge disposal per m.g. sewage	1.68	2.72	5.92	6.90	3.46
Cost of sewage-treatment processes per m.g. sewage	8.45	10.65	11.16	9.36	9.91
Net cost of sewage treatment, sludge disposal, interceptor system, sewage pumping, etc., per m.g	14.78	15.62	20.14	22.93	18.37

FIG. 2—DETAILED VIEWS OF EQUIPMENT USED IN THE MILWAUKEE SEWAGE PLANT.



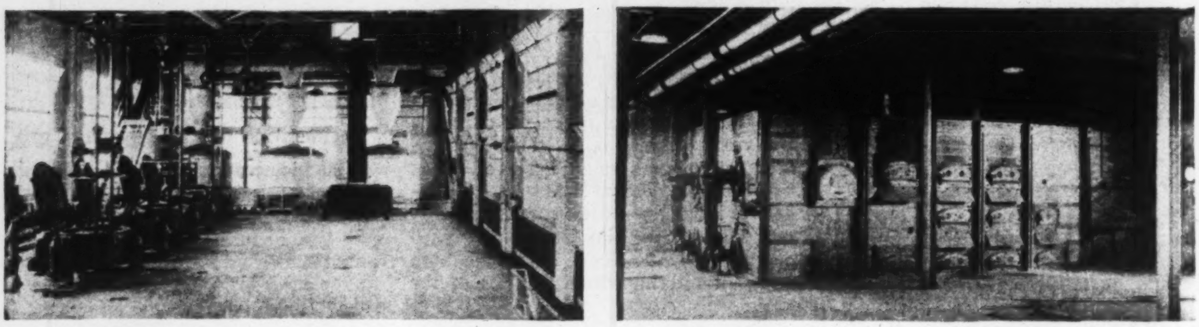
Fine screen plant: Eight screens, 8 ft. in diameter, 8 ft. long, $3\frac{3}{32}$-in. slots.

Power plant: Four turbine-driven blowers, four turbine-driven generators.



Filter room: 24 vacuum filters, 12-ft. diameter, 14 ft. long.

Dryer room, firing end: Nine units, 7-ft. diameter, 60 ft. long.



Centrifuges for dewatering screening and sludge.

Incinerator for screenings and grit: Two 20-ton units.

It should be noted that facilities at Milwaukee have not yet been provided for determining the weights of grit and screenings before centrifuging and that the moisture figures given at this stage are based upon analyses of composited samples.

Operation and maintenance costs

Since this plant was placed in operation officially, on Jan. 1, 1929, detailed cost figures of operation and maintenance have been recorded continuously. The average net annual cost (revenue from the sale of Milorganite deducted) of operation and maintenance of the treatment plant, intercepting sewer system, sewage pumping station, etc., for the four-year period, exclusive of capital charges on the investment, is as shown in the accompanying Table III. It will be noted that during 1931 and 1932 the revenue from Milorganite was less than during the two preceding years, and consequently the net operating costs of the plant were higher. It will also be observed that the amount of Milorganite revenue has a great influence upon the total expenditure necessary for operation.

Cost figures applicable to the treatment of sewage alone, exclusive of the cost of waste-sludge disposal, show that for the four-year period this treatment was accomplished at an average unit cost of $9.91 per m.g.

Cost of compressed air

In the activated-sludge process a substantial portion of the total cost is represented in compressed air. At the Milwaukee plant steam-turbine-driven turbo blowers are used to compress air to a pressure of 9 lb. per sq.in. The average cost over the four-year period has been $3.59 per million cubic feet of free air. The average cost of air per m.g. of sewage treated was about $5.40, upon the basis of 1.5 cu.ft. of air per gallon of sewage. This cost of air compression represents about 55 per cent of the total treatment cost.

In all the foregoing cost tabulations the incineration of screenings and grit is not included. The costs reported do, however, take into account the removal of these materials from their source of origin and their disposal in the area provided.

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Effect of Welding on Steel

A study of the changes induced in steel by welding and cutting operations is being undertaken jointly by the Bureau of Standards and the Bureau of Construction and Repair of the U. S. Navy. The study will be conducted largely by metallographic methods and has been begun as a result of the Navy Department's new construction program in which it is planned to make extensive use of welding.

Welded Bridge in Germany Sets New Records

Structure at Dresden consists of 13 spans, is 1,040 ft. long and required 431 tons of steel plate, shop-fabricated into girders and floor beams by an automatic welding machine

By René Leonhardt
Berlin, Germany

THE recently completed Schlachthof bridge in Dresden, Germany, which is 1,040 ft. long and crosses the Ostra tidal channel, a floodwater tributary of the Elbe River, in thirteen plate-girder spans varying in length from 72½ to 86 ft., is the longest welded bridge in Europe and involves a greater tonnage of welding than any other bridge in the world. The main girders and floor beams are built up from plates in the shop, using an automatic welding machine; they represent total tonnages of 299 and 132, respectively. Other large welded bridges of the world (all trusses) were described in *Engineering News-Record*, March 24, 1932, p. 439. The longest welded bridge yet built is a California state highway structure near Merced (*Engineering News-Record*, March 31, 1932, p. 463). This latter structure, however, is notable only for its length of 1,380 ft.; a relatively small amount of welding is involved, since girders and floor beams are rolled sections and not built up by welding as is the case at Dresden.

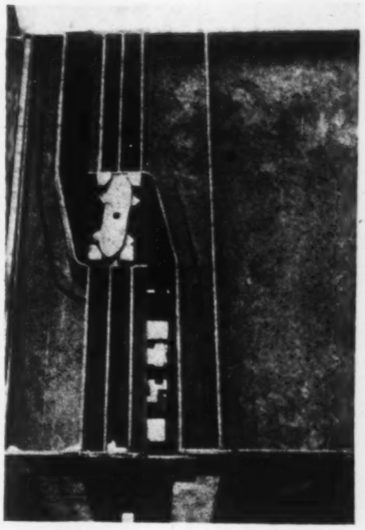

Fig. 3—Expansion in the main girders is taken care of by means of rocker bearings located at the center line of the web.

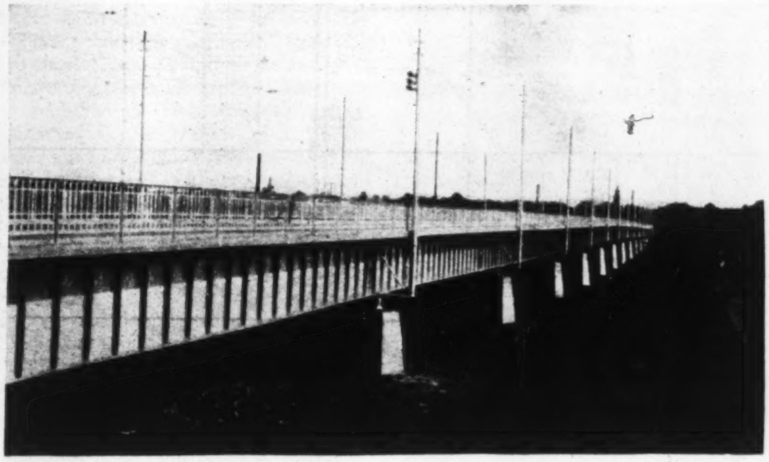

Fig. 1—Welded plate-girder bridge in Dresden, Germany, represents the largest welded bridge job yet undertaken.

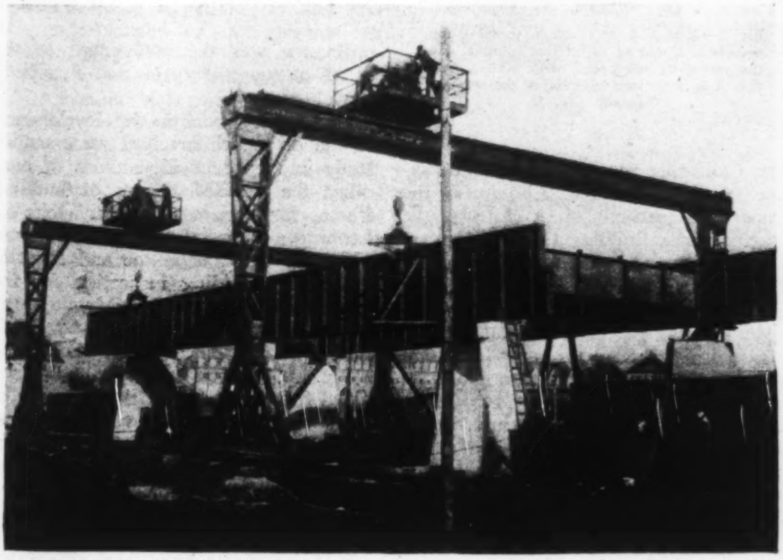

Fig. 2—Two gantry cranes were used to erect the shop-welded girders and floor beams of the Dresden bridge.

The main girders of the German bridge are 80 in. deep and spaced 29½ ft. apart. They support a 33½-ft. roadway, designed for vehicle traffic and a single-track tramway, as well as 6½-ft. sidewalks on either side. For the main girders a ½-in. web plate is used, and the flanges consist of plates 11¾ in. wide, varying in thickness from ⅞ to 1$\frac{3}{16}$ in. Flanges and web are joined by $\frac{7}{32}$-in. fillet welds. Stiffener plates, 1 in. thick, also serve as connecting plates for the floor beams, which are riveted to the main girders in the field. Main-girder flange splices are made by means of V-shaped joints and butt welds; no splice plates are used. Expansion in the main girders is taken care of by means of rocker arms placed at the quarter points of the bridge (Fig. 3).

The floor beams, spaced at about 13-ft. centers, consist of 46x⅜-in. web plates and flange plates 11¾ in. wide, varying in thickness from $\frac{9}{16}$ to 1⅛ in. The webs are reinforced by flat iron and T-iron sections, which are continuous fillet-welded by hand.

No diagonal bracing is used in the structure, wind forces being resisted by the reinforced-concrete roadway. Angle lugs welded to the top flanges of the floor beams help tranmit the wind forces to the concrete mass of the deck.

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Austrian River-Flow Studies

In an article on the effect of temperature on river flow (*ENR*, Oct. 5, p. 410), it was stated that the studies described were made in Germany. This was an error, as the studies were made in the Austrian government laboratories.

Earthquake Design for an Eight-Story Apartment House

Building in San Francisco designed to carry a seismic force of 1 per cent in frame and 4 per cent in walls—Additional cost is less than capitalized saving on insurance policies

By Harold B. Hammill
Consulting Engineer, San Francisco, Calif.

DEFINITE figures from comparative bids on two alternate designs for an eight-story apartment building in San Francisco showed that the provision for a 4 per cent earthquake force increased the cost of the structure 1.9 per cent over a design for vertical loads only. When the capitalized cost of earthquake insurance plus the cost of the higher fire insurance for the alternate design was considered, the cost of the earthquake-resistant design was actually less. The design was prepared in anticipation of the adoption of a proposed earthquake ordinance by San Francisco, which had been prepared and was under consideration by the board of supervisors at the time this design was made.

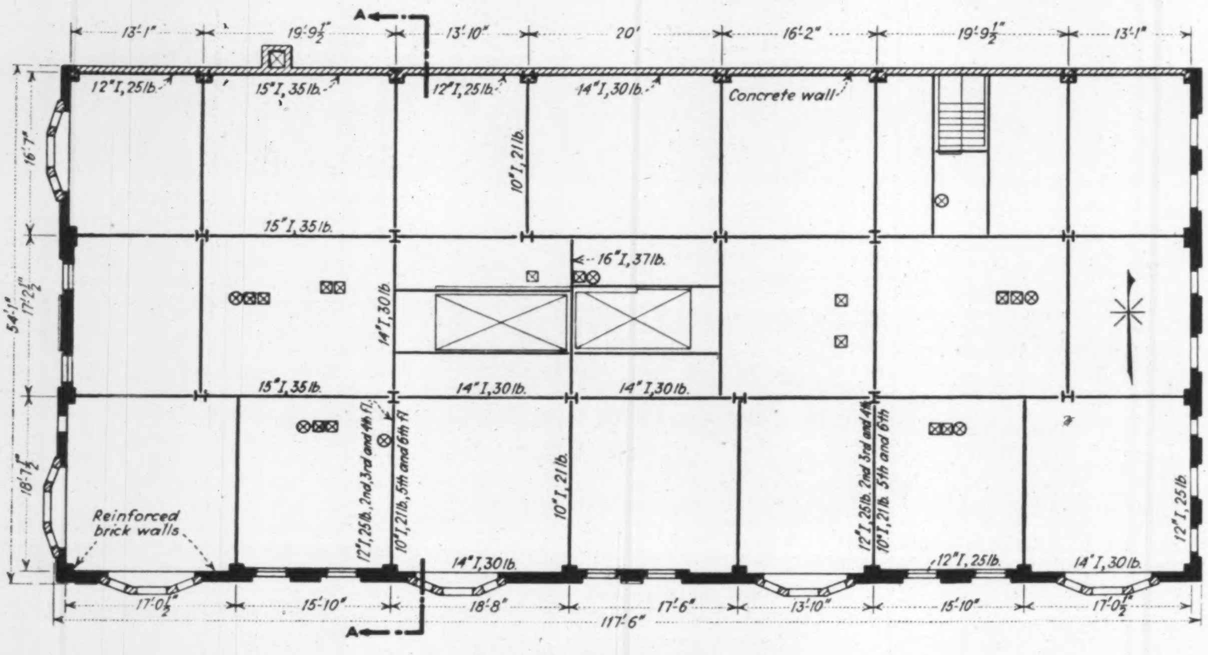


Fig. 1—Typical floor framing, showing the successful lining up of interior columns and the extent of reinforced brick walls. Section A-A is the one analyzed in the moment diagram, Fig. 2.

Earthquake code

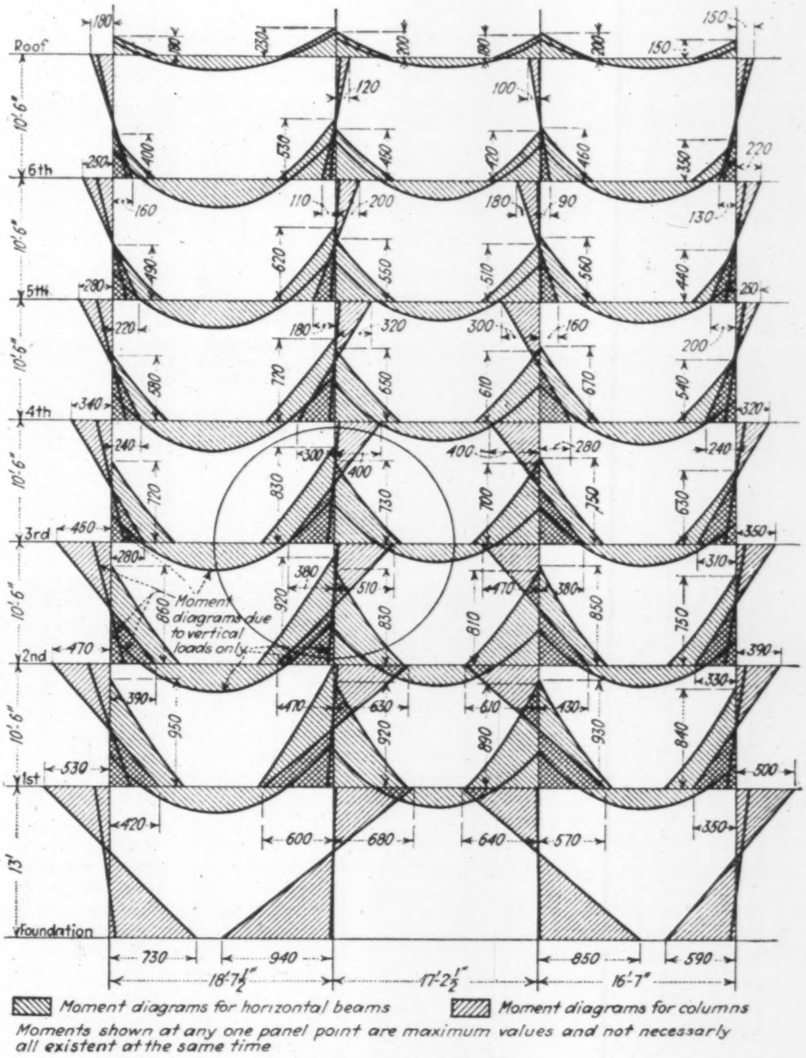
For a number of years the engineers and architects of California have realized that many city building ordinances lacked important provisions regulating building design. It was not until 1925 that a movement was started to improve building conditions; this developed into the study and preparation of a state uniform building code under the sponsorship of the California State Chamber of Commerce. The organization compiling this code consisted of committees both in southern California and in northern California representing the American Society of Civil Engineers, the American Institute of Architects, the Pacific Coast Building Officials Conference and the Associated General Contractors of America.

In the development of a proper uniform building code for this state, it was realized that it was extremely important to include provisions requiring definite resistance to earthquake forces. A limited amount of research information on the subject was available, certain experiments on models of buildings having been conducted on the "shaking table" at Stanford University. Using this information, but relying principally on the judgment of those engineers who ar members of the code committee of th American Society of Civil Engineers, a chapter was drafted covering minimum requirements for earthquake resistance.

Because of the economic situation it was impractical for the state chamber of commerce to continue its support, and the work of compiling the building code was discontinued. Local engineers realized San Francisco's particular need for an earthquake ordinance and urged that the proper provisions be incorporated in the city's present building code. The earthquake chapter as written by the building code committee was submitted to the members of the Structural Engineers Association of Northern California for criticism and suggestions. Certain provisions were modified to conform to suggestions made by members of this association, and the proposed ordinance was then submitted to the board of supervisors of San Francisco for adoption.

Preliminary work in the development of the ordinance involved an extended study in the practical methods of handling the detailed design of building frames for horizontal forces. John B. Leonard, chairman of the local engineering code committee and superintendent of building inspection for the city of San Francisco, delegated the working out of this problem to S. M. Cotten, in his office. After months of study Mr. Cotten developed a method based fundamentally on the principle of slope deflection that is very clear and easy to apply; this method was used in determining the moments in the structural elements of the design of the apartment house here described.

Subsequent to the preparation of the



Moments shown at any one panel point are maximum values and not necessarly all existent at the same time

Moment values are in kips inch lbs.

Fig. 2—Moment diagram of a transverse frame (section A-A, Fig. 1) showing maximum summation of moments for beams and columns. The detail moments of a typical beam-column connection (in circle above) are shown in Fig. 3.

ordinance the earthquake at Long Beach focused public opinion on the need for earthquake-resistant design. As a result, state legislation was enacted (*ENR*, June 1, 1933, p. *722*) requiring all buildings in California to be designed for definite horizontal forces. Some provisions of the proposed city ordinance were in conflict with the state legislation. The ordinance has now been amended to agree and is before the supervisors for adoption. Among the various provisions of the original ordinance, which was the basis of the present design, was the requirement that a building founded on a soil capable of withstanding a pressure of 4 tons per sq.ft. should be designed to resist a horizontal force of 4 per cent of its weight. If a flexible story were incorporated in the design, a reduction in the 4 per cent factor would be permitted.

In determining the structural sections required to resist earthquake forces, the unit working stress for the materials could be increased 100 per cent for all members except columns, which were limited to an increase of 75 per cent. The ordinance further provided that the structural frame should be designed to resist either 1 per cent of the weight of the building or 15-lb. wind pressure, whichever is the greater, with an increase in working stress of 33⅓ per cent. One clause in the ordinance provided that any connection that is restrained must be proportioned to resist the stresses due to moments from vertical loads as well as from horizontal loads.

Shortly after the ordinance was presented for adoption to the board of supervisors, the writer was retained to prepare the structural design of an apartment house to be built at 25th and Bartlett Sts., San Francisco. On the supposition that the proposed ordinance might be adopted before the plans for this building could be completed, it was decided to design it in accordance with these earthquake provisions.

The building is 54x117½ ft. and was originally planned for six floors and one garage, but before the plans were completed a mezzanine floor was added to provide additional garage space. The structural elements consist of a steel frame with 2½-in. concrete slabs supported on junior beams for the apartment floors and reinforced-concrete construction for the garage floors. The first-story walls and the entire rear wall are of concrete. The front and two side walls above the first story are of reinforced brick.

With the cooperation of the architect a very satisfactory arrangement of the structural members was obtained (Fig. 1). All the columns are lined up to form complete longitudinal bents. In a transverse direction there are four complete bents in which all the transverse horizontal forces are concentrated. Of the 32 columns, 16 are turned with webs north and south and 16 with webs east and west. Due to practical difficulties, all connections of beams to column webs are designed to transmit shear only. Only the connections of beams to column flanges are designed to develop moments. The 2½-in. concrete floor slabs are designed to act as horizontal girders to transmit horizontal forces to the resisting bents and to the walls. The structural-steel frame is designed to carry 1 per cent of the weight of the building as a horizontal force.

The moment diagrams for a typical transverse structural-steel bent that carries its proportion of the earthquake forces in the north and south directions is shown in Fig. 2. These moment diagrams for both horizontal and vertical loads are shown for a building consisting of six stories and one garage floor, the structure for which the complete analysis of the frame was made. After the addition of a mezzanine floor to the design, the moment values were modified without making another complete frame analysis. All cost figures are for the structure as finally designed and constructed.

Referring to the moment diagram and the detail (Figs. 2 and 3), the webs of the columns in the transverse frame are in the plane of the frame, and since all beams connect to column flanges, they are restrained at both ends. The end moments of all beams were determined for vertical loads on the basis of complete end restraint. A study was made for the angular rotation occurring at the end of a typical beam, from which information a percentage factor was obtained for reduction of all end moments that had been computed for complete restraint. The closing lines for the moment diagrams were accordingly adjusted. The diagram shows the vertical-load moment diagrams for all beams and columns. The moments in all beams and columns were then determined for a lateral load equal to 1 per cent of the weight of the building.

Since the horizontal force may be applied in either direction, only the moments for these forces are shown at the ends of beams and columns that produce critical values—i.e., only those moments that are of the same sign and therefore added to vertical load moments. Since the negative moments in beams are so much larger than the positive moments and are the values that fix the size of the sections, the moment diagrams for horizontal forces are shown only above the datum lines.

All beams with ends restrained were connected to column flanges with split I-beam connections. The web of the I-beam connector was left as long as possible to serve as a coverplate for the main beam, thereby producing an increased section at the point of maximum moment. In many cases 1-in.-diameter rivets were used for connection of I-beam connectors to columns.

The provision of the ordinance that the building must carry a horizontal force of 4 per cent of the weight is met in this design by providing proper resistance in the walls, which are far more rigid than the elements of the structural steel frame. To meet the stresses as allowed in this ordinance, it was found necessary to reinforce the brick walls.

Critical stresses existed in the east and west walls and determined the amount of reinforcing steel that is used in all the brick masonry. Computations for steel reinforcement were based on the formulas for shear reinforcement of concrete beams. The shear in the critical buttress of the east and west walls was 56 lb. per sq.in. The ordinance provided that the maximum allowable shearing stress in plain brick masonry for dead and live load should not exceed 20 lb. per sq.in. for mortar as used on this job. A 100 per cent increase for earthquake forces brought the allowable value up to 40 lb. per sq.in.

Since reinforcement was required, an amount has been provided conforming to the minimum requirements of reinforced-concrete construction. All bars are round and are placed in the mortar joints in the center of the 8-in. wall. Two vertical bars, one ½ in. and one ⅜ in. are placed each side of all openings. Two ⅜-in. horizontal bars are placed at top and bottom of all the openings. In all vertical buttresses ⅜-in. bars at 8-in. centers are placed horizontally between spandrel sections. Vertical bars in the spandrel sections are ⅜ in., with a maximum spacing of 24 in. All vertical bars are guided and are anchored to the frame by passing through holes in the flanges of the spandrel beams. Vertical bars close to columns are tied to them with ¼-in. rods at 12-in. spacing. There are six tons of reinforcing steel in these brick walls, which is equivalent to 1 lb per sq.ft. of net area of wall

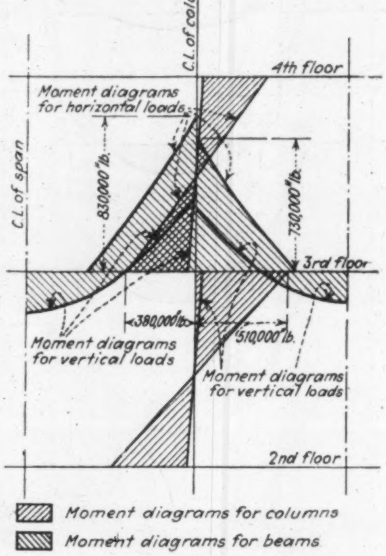

C.L. of columns
4th floor
Moment diagrams for horizontal loads
C.L. of span
830,000"lb.
730,000"lb.
3rd floor
380,000"lb.
510,000"lb.
Moment diagrams for vertical loads
Moment diagrams for vertical loads
2nd floor
▨ Moment diagrams for columns
▧ Moment diagrams for beams

Fig. 3—Moment diagram at a typical panel point, showing the analysis of the total moments for both beam and column.

Before the design, as described, was completed, a local steel fabricating shop was permitted to make an alternate design based on the use of certain foreign sections that this shop had in stock. The alternate design was prepared in accordance with the existing San Francisco building ordinance, which does not require any building under 102 ft. in height to be designed for horizontal forces. This design for the structural frame was based on the use of timber floors and timber joists and of course made no provision for resistance to horizontal forces.

Since both plans were submitted to all contractors bidding on the job, comparative cost data are available. The low bid for the structure providing resistance to horizontal forces was $150,000, or $14,200 more than that for a structure with the timber floor system as designed by the local steel shop. The amount of $14,200 represents the difference in cost of the steel frames plus the difference in cost of the floor systems, one being concrete and the other timber. The cost of the earthquake-resistant structural frame as designed by the writer was:

212 tons of structural frame..	$17,413
Junior beams	6,317
	$23,730

Some time after the bids had been accepted, the local steel shop presented a figure of $20,890 to the owner as the cost of furnishing the structural frame, designed by them, plus the junior beams. The extra cost in the structural frame for the earthquake-resistant provisions of the ordinance, therefore, amounts to only $2,840, which is 1.9 per cent of the cost of the building. The owner decided to build a structure that would possess resistance to earthquake forces and accordingly finds that it is not necessary to carry earthquake insurance. For this reason, he does not intend to carry any.

Earthquake insurance would have been considered necessary if the building had been constructed in accordance with the provisions of the present San Francisco building code. The annual cost of earthquake insurance would have been at least $880 per year. There is an annual saving in fire insurance premiums amounting to $166 resulting from the use of concrete floors instead of timber floors. The total annual saving is at least $1,046. This amount capitalized at 6 per cent gives a sum of $17,400, or $3,200 more than the difference in the cost of the two complete structures, and represents a saving of 2.1 per cent.

F. W. Hanchett is the owner of the apartment house. William Clement Ambrose was the architect, and Atkins and Parker prepared the mechanical and electrical design. G. W. P. Jensen was the general contractor.

Water-Power Projects in Canada

DURING the ten months of the current year, work has continued on several large Canadian water-power developments already under construction at the beginning of the year. In the province of Quebec the MacLaren-Quebec Power Co. completed and brought into operation its 136,000-hp. plant on the Lievre River. The Shawinigan Water and Power Co. recently announced the resumption of work on its development at Rapide Blanc on the St. Maurice River. Owing to a greatly increased demand for power that has developed, it is planned to have an initial installation of 80,000 hp. ready for operation by May 1, 1934. The Beauharnois Light, Heat and Power Co. recently awarded a contract for five additional units in its plant at Beauharnois. These are each of 50,000-hp. capacity, and installation will extend from December, 1934, until 1937.

In Ontario the uncompleted canyon development of the Ontario Power Service Corp. on the Abitibi River was acquired by the Hydro Electric Power Commission, and work was resumed on the installation of generating machinery. Two of the 66,000-hp. units are at present in place. In British Columbia the West Kootenay Light and Power Co. continued the construction of a development on the Goat River near Erickson, which will have an initial installation of 800 hp. and an ultimate capacity of 1,600 hp. No other water-power undertakings of magnitude are at present under construction.

Steel in Sea Water Examined After 31 Years' Exposure

Metal loss from corrosion and abrasion on 6-in. solid circular piles is confined to tidal range and is relatively small in amount

By J. S. Unger
Manager, Central Research Bureau,
Carnegie Steel Co., Pittsburgh, Pa.

A RECENT inspection of some solid-section circular steel piling, installed 31 years ago in the waters of the Gulf of Mexico and unmaintained since, has furnished some interesting and significant data on the corrosion resistance of steel in tropical sea water as well as its ability to withstand abrasion from sand particles. Briefly, the piling, which was 6 in. in diameter and of solid section, was found to be encrusted with a considerable thickness of scale; loss of metal from corrosion varied from ½ in. at the top to $\frac{1}{16}$ in. 4 ft. from the top; wearing away of the metal was found to be fairly uniform; and there was a minimum of localized pitting.

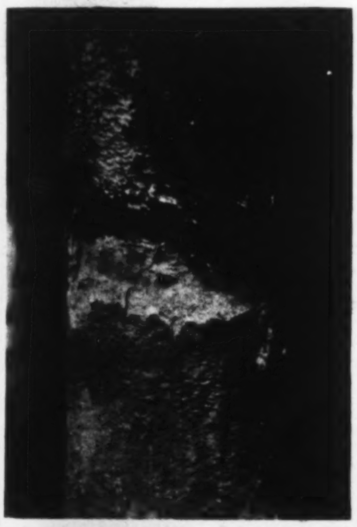
The piling, inspected during April and June, 1933, by G. A. Anderson, of the Carnegie Steel Co., supports coal sheds and piers built by the U. S. Navy Department in 1902 at Dry Tortugas Islands, located about 75 miles northwest of Key West, Fla. The piling has a wedge-shaped point forged at one end to permit driving into the coral rock for an average depth of 8 ft. The steel was rolled at the Homestead Steel Works of the Carnegie Steel Co. during the early months of 1902. It was the original intention to incase each pile in concrete, but it appears that this was never done, so that the only protection was the painting done when the work was completed about 1903. The coaling sheds and piers have not been used for many years, consequently no maintenance has been done on either the buildings or the piers. The buildings are in bad condition, and the structural-steel parts are practically destroyed. The piers also are in bad condition, as the timbers in the floor have rotted away and the steel substructure has been destroyed in several places.

The northern portion of the Gulf Stream touches the islands, so that the average temperature of the ocean is about 82 deg. F. and the average rise and fall of the tide where the piling is installed is about 1½ ft. The sand-laden waves strike and during storms submerge all of the steel and wooden parts of the pier, subjecting them to the combined effects of the abrasion due to the water and sand and to the corrosion resulting from being alternately wet and dry. Near the high-water level the destruction by abrasion of the smaller steel parts was probably as great as that due to actual corrosion. Information secured from the investigation gives a valuable and accurate picture of what has happened during the exposure of these piles to a tropical sea for 31 years.

An average pile was selected in a convenient location where the depth of the water permitted working. This 6-in. pile was measured with calipers before an encrusting layer of scale was removed. The scale was then broken off down to the metal and the pile again measured. The table on the following page gives the figures obtained.

Fig. 2 shows a portion of the structure before and after the scale was broken away. The scale was fairly uniform, although, because of barnacles, seaweed and other foreign matter mingled with it, it appears to be quite rough. Fig. 3 is a sketch of an angle which was originally 3x3x7/16 in., which had been broken off through a couple of rivet holes. This angle, when analyzed, showed the following composition: carbon, 0.25; manganese, 0.43; phosphorus, 0.020; sulphur, 0.029; and copper, a trace. Fig. 3 indicates that the amount of metal lost was proportionately much greater than in the piling.

Fig. 1—Scale chipped from pile to show thickness. Metal loss from corrosion at this point, which was between 2 and 3 ft. from the top of the pile, was about ⅛ in.



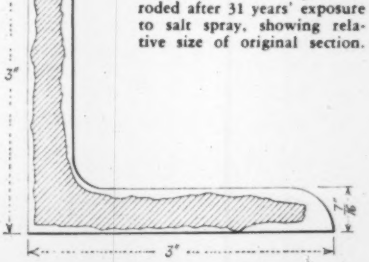


Fig. 3—Sketch of angle, corroded after 31 years' exposure to salt spray, showing relative size of original section.

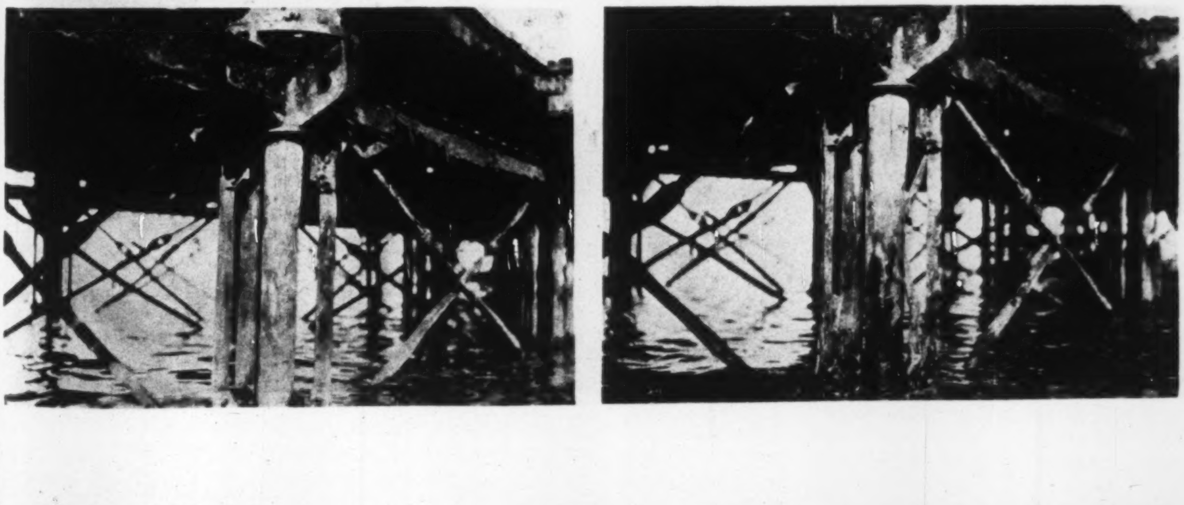


Fig. 2—Part of the pier-supporting structure, showing piling and structural members before and after scale was removed.

SCALE AND CORROSION DATA FOR TYPICAL STEEL PILE

Distance From Top of Pile, In.	Diameter With Scale Attached, In.	Diameter of Metal Remaining in Pile, In.	Thickness of Scale, In.	Loss of Metal by Corrosion, In.
3	7½	5½	2	¼
12	6 7/16	5 9/16	⅞	3/16
24	6½	5⅝	⅞	⅛
*36	6 9/16	5⅝	15/16	⅛
51	6⅛	5 11/16	7/16	1/16

*Approximate mean low-water level.

However, this can be expected, as the angle had much more surface exposed compared with its mass than did the pile. The same condition was also noticed in several tierods that were almost worn through in spots. Examination of the steelwork showed that there had not been much pitting at any particular point and that the steel had worn away fairly uniformly over the structural members and the pile itself.

Taking into consideration the fact that none of the steel parts has been given any maintenance since the installation 31 years ago, the investigation shows the piling to be good for many years of service, indicating as well the value of sheet-steel piling in sea water.

Maintenance Methods on Stabilized Gravel Roads

Discussion of methods of providing smooth-riding surface, keeping gravel compacted and preserving original crown and thickness

By B. C. Tiney

Formerly Maintenance Engineer, Michigan Highway Department, Lansing, Mich.

DEVELOPMENTS in oil research during the past few years have made possible the design and construction of gravel roads having increased stability in both wet and dry weather. Experimental work by the U. S. Bureau of Public Roads and other organizations has not only shown the important part played by the finer constituents of the gravel in producing stability but has developed laboratory tests which enable the engineer readily to determine the proper proportions of sand and clay which should prevail in these fines.

The closely bound gravel surface produced by this modern design presents a different maintenance problem than that which attended the old-type loosely bound gravel road.

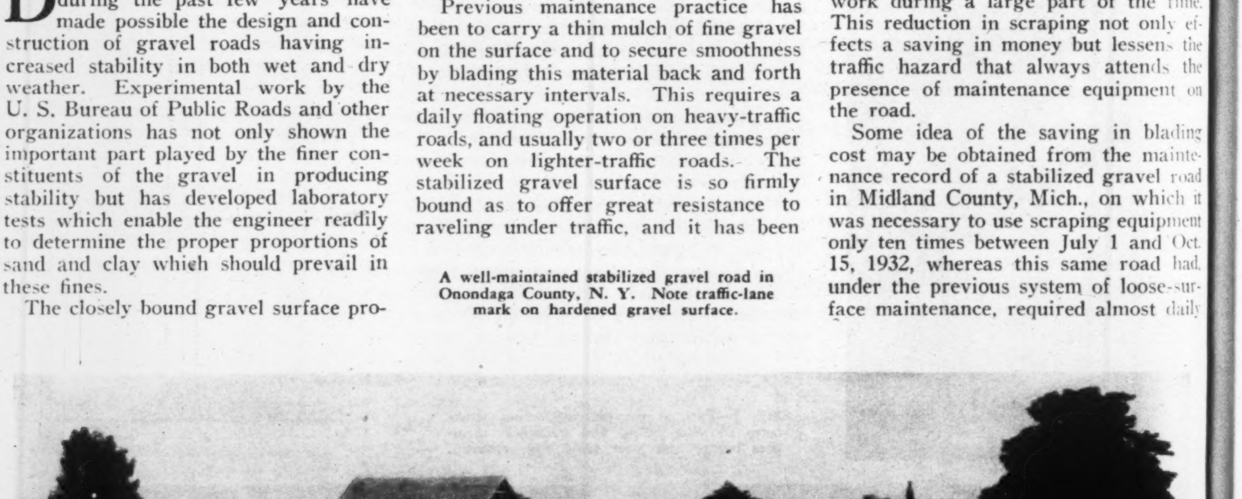
Previous maintenance practice has been to carry a thin mulch of fine gravel on the surface and to secure smoothness by blading this material back and forth at necessary intervals. This requires a daily floating operation on heavy-traffic roads, and usually two or three times per week on lighter-traffic roads. The stabilized gravel surface is so firmly bound as to offer great resistance to raveling under traffic, and it has been found that smoothness can be maintained without any loose mulch on the surface. In fact, the presence of the latter is shown to be detrimental, as it acts as an abrasive under the wheels of vehicles. Blading only after rains has been proved sufficient to preserve smooth-riding qualities.

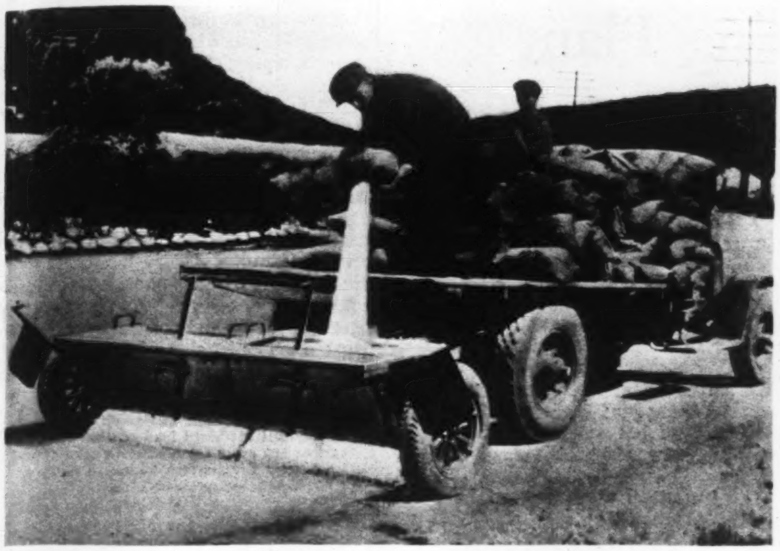
A possible exception might be the case of a very prolonged dry period, when a few casual holes would require patching. This should be done with the same grade of stabilized gravel used in the construction of the road, but with the maximum size of stone reduced for shallow depressions. Calcium chloride should be added to the patching gravel to provide moisture for compaction. Usually even such minor patching is unnecessary.

The time in which effective blading of stabilized gravel roads can be done is limited to the drying-out period following rains. It is therefore essential that intensive scraping be carried on during this restricted period. A sufficient number of scraping-equipment units should be available to cover the work quickly. While this does not minimize the number of units required in a maintenance organization, as compared with maintenance of the loose-surface type of gravel roads, it does greatly reduce the number of days each unit is used per year. Equipment operators may be employed on other phases of highway maintenance work during a large part of the time. This reduction in scraping not only effects a saving in money but lessens the traffic hazard that always attends the presence of maintenance equipment on the road.

Some idea of the saving in blading cost may be obtained from the maintenance record of a stabilized gravel road in Midland County, Mich., on which it was necessary to use scraping equipment only ten times between July 1 and Oct. 15, 1932, whereas this same road had, under the previous system of loose-surface maintenance, required almost daily

A well-maintained stabilized gravel road in Onondaga County, N. Y. Note traffic-lane mark on hardened gravel surface.





Calcium chloride in flake form is applied by mechanical distributors in retreating stabilized gravel roads.

scraping, or a total of approximately 90 scrapings during corresponding periods of other years. The road serves an oil-producing territory and carries a fairly heavy traffic.

While this difference in scraping costs would not prevail to such a large extent during the rainy seasons of early spring and late fall, it may be conservatively estimated that the stabilizing of a gravel road will reduce the average annual scraping cost by 33 to 50 per cent, effecting a saving of $65 to $100 per mile.

Compaction and dust elimination

A prime requisite in preserving compactness in a gravel road is the maintenance of the proper moisture content in the gravel at all times. The irregularity of rains and the rapid evaporation of water from the road surface produce great variations in this moisture content. Such variations may be regulated by the application of calcium chloride, which tends to preserve a constant dampness in the gravel, preventing raveling and dust. Calcium chloride dissolves itself in moisture drawn from the air, and the resulting solution, penetrating into the road surface, has a resistance to evaporation which is much greater than that of plain water. Rain causes the calcium chloride solution to penetrate deeper into the gravel bed, leaving a very weak solution near the surface. In drying weather the surface moisture evaporates and the stronger solution rises to the surface by capillarity, where its resistance to evaporation creates a protective seal which preserves the moisture in the lower part of the gravel course. If blading is done only after rains, when the stronger calcium chloride solution is not so close to the road surface, there is much less tendency to disturb and dissipate it by exposure to the air.

In the use of calcium chloride as a dust palliative, it has always been evident that this material remained effective for much longer periods in gravel having a clay binder than in gravel having a sandy filler. It has also been apparent that the presence of loose gravel tended to shorten the useful life of a treatment. Continual movement of such loose gravel under traffic and scraper blades exposes new surfaces to the air and promotes evaporation. Usual dust-laying practice on the loose-surface type of gravel road is to apply a total of about 10 tons of calcium chloride per mile per year in two or three applications. On the closely bound gravel road, having the proper balance of clay and sand in the fines, it has been shown definitely that more effetive and lasting dust elimination can be obtained with from 20 to 25 per cent less tonnage of calcium chloride. This saving may be conservatively stated to be at least $50 per mile per year.

Light applications of calcium chloride, ranging from 1 to 2 tons per mile, have been found to be effective in preserving moisture in stabilized gravel surfaces. More frequent use of the material, in these quantities, lessens the possibility of loss from traffic and rains during the periods when the flakes are dissolving and penetrating into the gravel.

The most favorable time to apply calcium chloride is during the drying period just following a rain, after the surface has been bladed to proper smoothness. The moisture in the road at that time hastens dissolving and penetration. In the absence of rain, application in the early hours of the day, when the air has high relative humidity, is very desirable. Application just prior to a rain should be avoided because of the loss from washing off the road.

The original crown of the road should be maintained by blading operations. About ½ in. per foot is considered a desirable crown for a stabilized gravel surface. This provides for a rapid run-off of a stormwater and avoids the formation of pools of water on the road surface, which would cause undue softening and loss of stability.

Good maintenance requires that the original thickness of the road be preserved by periodic resurfacing. On an unstabilized or loosely bound gravel road the annual loss of material by wind action, vehicle suction and the wash of rains is appreciable. Some attempts have been made to measure this loss. A study of the amount of resurfacing gravel required to maintain the original thickness on 22 sections of unstabilized untreated gravel road, over a period of three years, was made by A. H. Hinkle, maintenance engineer of the Indiana state highway department, and reported in the 1926 *Proceedings* of the Highway Research Board. This report indicates a logical variation of gravel loss with traffic volume, and shows that for an average daily traffic of 800 vehicles the average gravel loss is about 230 cu.yd. per mile per year. Assuming the unit cost figure of $1.50 per cubic yard for gravel in place on the road, we have an annual resurfacing cost of $345 per mile.

The loss of gravel from a road surface by the action of traffic, winds and rain is the result of lack of cohesion in the road metal. This quality is developed to such a degree in the stabilized gravel road that a large part of the usual periodic resurfacing cost is saved.

As good drainage is an important element in the successful maintenance of gravel or any other type of road surface, the side ditches and drainage structures should be kept well cleaned, and the road shoulders should not be allowed to become built up above the elevation of the gravel surface.

Summary

Practical demonstrations have shown that a well-balanced mixture of the soil fines in a road gravel, together with the constant presence of the correct amount of moisture, will produce a very stable road metal. With proper maintenance and regulation of moisture, this furnishes an all-weather road of fine riding qualities at a maintenance cost appreciably less than that of the loose-surface type of gravel road. It is a safe road because the hazards of dust and loose gravel are eliminated and the wet-weather texture of the surface is sufficiently gritty to prevent slipperiness. In the event that a prolonged rainy period should develop indications of a slight excess of clay on any section of a stabilized gravel surface, a thin surface treatment of fine gravel or coarse sand will remedy the condition. If the road is stabilized under laboratory control, it is very unlikely that any excess of clay will occur.

Highway Batching Plant Handles Bulk Cement

Cement for California road job is hauled 100 miles in special cylindrical-body trucks

THE USE of bulk instead of sack cement for highway paving work is well illustrated by the procedure and equipment adopted for the first section of the Ridge Route cutoff between Castaic and Gorman, Calif. This is a 27-mile concrete paving project with a pavement width of 30 ft. It is being built for the California state highway department. Other sections of this highway connecting the towns of Castaic and Grapevine, are now being built, and still other parts are to be put under contract in the near future. All of the 27-mile section between Castaic and Gorman is on new location and traverses an extremely mountainous and rough country. The present contract covers only the finish grading and concrete paving.

The saving of the differential in price between bulk and sack cement, also the saving in cost of cement handling, led the contractor to adopt the use of bulk cement for this work. The plant was installed adjacent to the work at Castaic. As shown in Fig. 1, it includes a roofed-over steel frame set on an earth ramp where the cement trucks are dumped, a cylindrical storage bin and a batching plant. Trucks dump into a large steel receiving hopper from which the cement is removed by a horizontal screw conveyor, which runs beneath a circular steel storage bin and to the foot of a vertical closed-type bucket elevator. This elevator carries the cement to either the rectangular steel batch bins or the steel storage bin. A fly gate, located in a chute at the top of the elevator, controls the flow of cement to the batching or the storage bin.

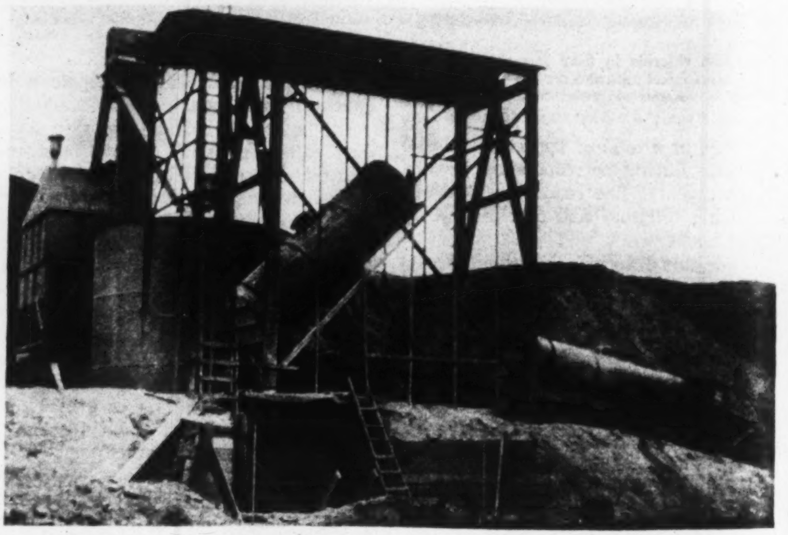


Fig. 2—Special tank bodies on truck and trailer haul combined load of 100-bbl. bulk cement 100 miles for highway work. Overhead hoist elevates tank bodies to dumping position.

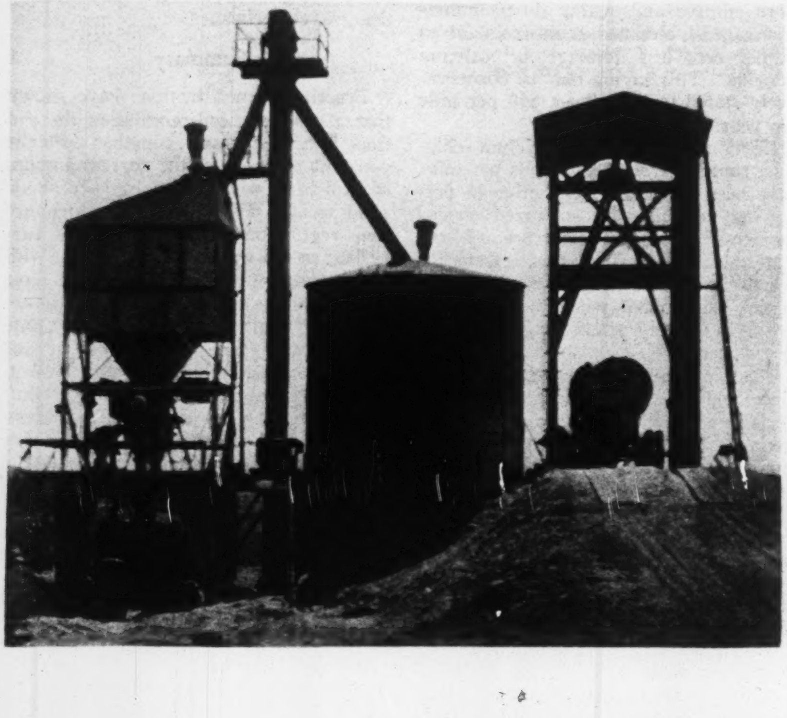


Fig. 1—Bulk-cement plant for California highway paving job. Trucks dump from ramp at right into screw conveyor passing under circular storage bin, the cement being elevated to batching plant at the left or to storage bin.

The circular steel storage bin has a capacity of 1,500 bbl. and is equipped with three cement gates located directly over the horizontal screw that runs beneath it. When it is necessary to draw cement from the storage bin, these gates are opened and the horizontal screw conveys the cement to the vertical bucket elevator and thence to the batching bin. The batching bin is a portable unit of 300-bbl. capacity. It is equipped with two electrically operated automatic cement-weighing batchers of 1,000-lb. capacity. These batchers are so designed that the required weight of cement per batch can be set off in advance on the scales and then, by means of push-button operation, the successive batches are measured out accurately and quickly.

Two cement-weighing units were installed to speed up the output of the plant. Two 27-E paving mixers are being used on this work, and it is necessary to have fast operation at the cement plant. Beneath these two weighing batchers are suspended two conical steel hoppers with canvas discharge spouts, as shown in Fig. 3. The operator measures out two batches of cement and discharges both these batches into the small storage hoppers. The truck hauls three batches to a load, and when the truck drives under the cement plant it receives two charges of cement immediately, while two more batches are measured out in the small batch bins. The truck is then re-spotted and receives the third batch. The entire cycle for load-

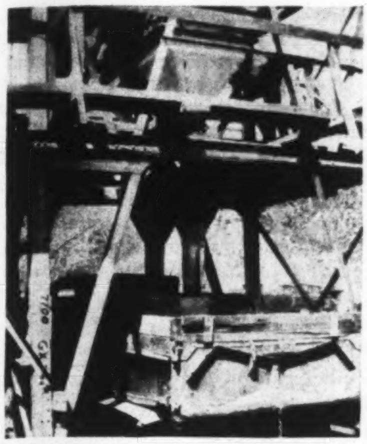


Fig. 3—Twin batchers load bulk cement in fast time. Third batch to complete truck-load is ready by time the truck has been re-spotted to receive it.

ing one truck requires only 30 seconds. The photograph, Fig. 3, was taken during the discharge of cement into the truck, showing that there is practically no dusting of cement in this operation.

Cement is hauled a distance of 100 miles from Monolith, Calif., in special trucks equipped with cylindrical tank bodies that are hinged to the truck frame at the rear end. At the rear end of each tank is a hinged steel door. No hoist is included in the truck; instead, the tanks are emptied by means of overhead cranes equipped with gasoline hoists mounted on the steel framework, as shown in Fig. 2. The tanks are lifted to an angle of about 60 deg. from the horizontal in being discharged. The cement is discharged from the tank through a canvas funnel into the steel receiving hopper that leads to the horizontal screw. Each truck has a capacity of 50 bbl. The trucks operate in units of a truck and trailer, each hauling 50 bbl., or 100 bbl. to the load.

This project is being built by the Jahn & Bressi Construction Co., of Los Angeles, with Joseph Muscolo as superintendent in charge. W. I. Templeton is resident engineer for the highway department. Information for this article was supplied by the Blaw-Knox Co., which designed and furnished the plant.

Sixty-Year-Old Trusses of Cast Iron Still in Service

Pennsylvania structures contain interesting details including unusual connection castings

By Harry K. Ellis
County Engineer, Chester County, West Chester, Pa.

TWO BRIDGES built almost entirely of cast iron are still in service over Saucon Creek, near Bethlehem, Pa. One of them (Fig. 1), is located on Walnut St., Hellertown, and is a through-truss span of 55 ft. 5 in. center to center of bearings. It originally carried a sidewalk on one side, but this has been removed. The cast-iron sidewalk brackets and a light cast-iron railing remain in place.

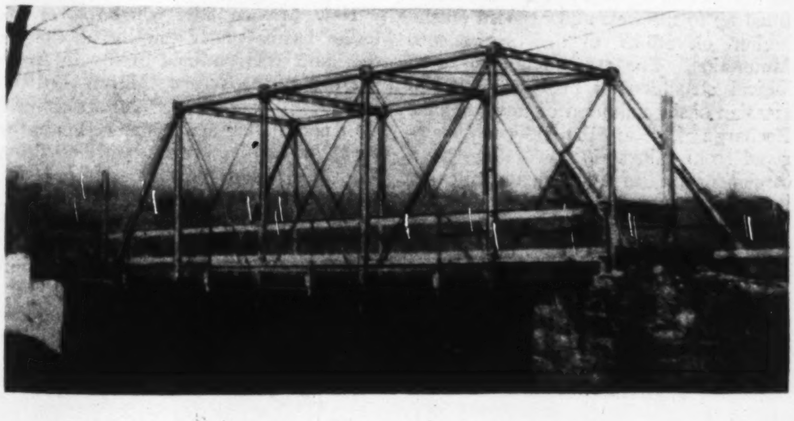


Fig. 1—Cast-iron truss bridge of 55-ft. span at Hellertown, Pa. Top chords and verticals are circular.

The trusses are 12 ft. on centers and 14 ft. 8 in. deep. They are built with all compression members of cast iron. The top chords and end posts are circular in section and taper from a maximum outside diameter of 7 in. near the middle to a lesser diameter at the ends. The posts are similar in section but with a maximum diameter of 5 in. Diagonal web members are rods of 1 and 1¼ in. diameter, not upset. Connections are made by passing the rods through the ends of the cast-iron vertical posts and fastening them with a nut on each end. This is shown in Fig. 2. The lower chords consist of four rods of 1-in. diameter in the end panels and 1¼-in. in the center panel. The smaller rods are upset but the larger ones are not. They are spliced together with a sleeve nut just outside the center panel. This may be seen in Fig. 2.

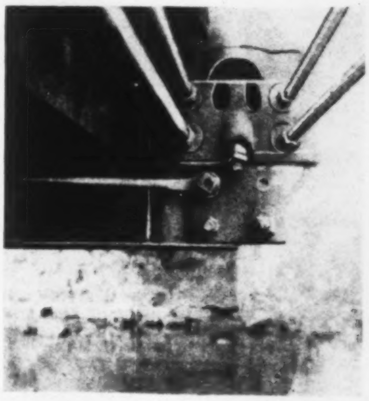


Fig. 2—Bottom panel-point casting on Hellertown bridge providing connection for diagonals, chords and floor beams.

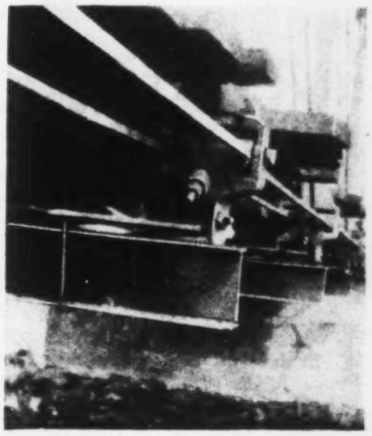


Fig. 3—Bottom panel-point detail of continuous-type cast-iron bridge. Note steel I-beams used to reinforce old cast-iron floor beams.

The floor beams also are of cast iron, 11¾ in. deep. The flanges are 4½ in. wide with a minimum thickness of ½ in. Diagonal and vertical stiffeners are cast integral with the web.

The top lateral system is of rods with cast-iron latticed struts at the panel points. No portal or swaybracing is used. The lower laterals are rods of ¾-in. diameter in the intermediate panels and 1-in. diameter in the end panels.

At the second crossing upstream from the Walnut St. bridge is a two-span continuous cast-iron bridge built by C. N. Beckel of Bethlehem in 1870. The spans are 51 ft. 10 in. center to center

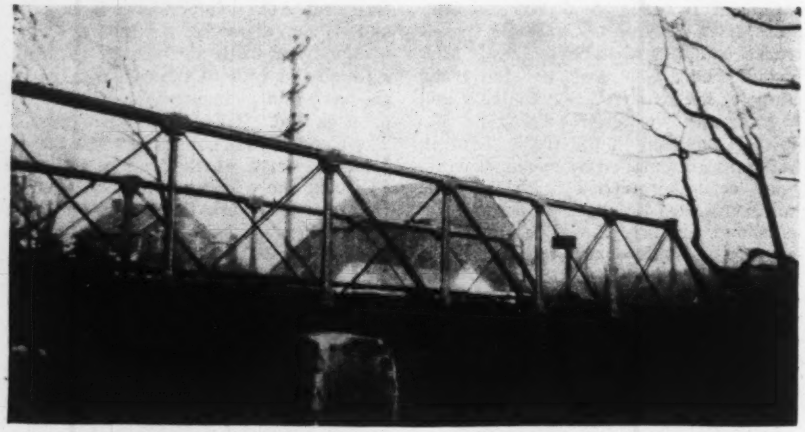


Fig. 4—Continuous-type truss bridge of cast iron in two spans of 52 ft.

of, bearings, and the trusses are 15 ft. on centers and 7 ft. 10 in. deep. All compression members are octagonal in shape, the top chords and end posts being 6 in. in short diameter and the vertical posts 4½ in. All diagonals are of rods which pass through the truss castings. The upper ends of the rods are formed into a round rivet head, and the lower ends are threaded and fastened with a nut. None of the rods has upset ends.

The lower chords are square eyebars connected to the panel points with pins. The trusses are not truly continuous, for the lower chord is a tension member in all panels. Probably the designer had continuity in mind, however, for the diagonals in the middle panel of each span consist of two 1-in.-diameter rods in one direction and a single rod of th same diameter in the other direction, a would be required in a continuous spa

The floor beams are of cast iron, 1 in. deep and similar in construction t those used in the Walnut St. bridg One of them has broken, and all of then have been reinforced by fastening stee I-beams beneath them. Horizontal ro bracing forms the lower lateral system

The expansion bearings of this bridg consist of a cast bed plate upon which rest two 3-in.-diameter rollers. The upper surface of the bed plate is rounded as shown in Fig. 5. Except that the truss casting does not rest centrally upon the rollers, the bearings are in excellent condition.

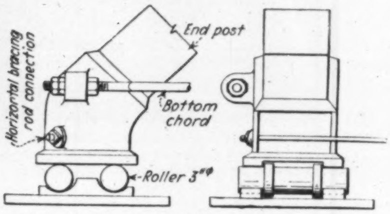


Fig. 5—Sketch of cast-iron expansion bearing on continuous-type bridge.

Well-Plugging Program Saves Irrigation Water

Old leaking wells in Rosewell artesian base in New Mexico have been a constant source of water loss—Situation outlined and plugging method described—State program wins support of water users

TO CONSERVE the water supply in the Roswell artesian basin, one of the most productive agricultural areas in the state of New Mexico, a program of plugging old leaky wells is in progress. Continued decline in the irrigation supply for more than a decade resulted in the passage of a law in 1931 giving the state control of the underground supply by declaring it appropriable, and also provided a fund to institute the well-plugging program. As hoped, this action of the state has been effective in arousing the water users, and a conservation district has been formed which will take over and carry on the conservation program. After considerable experimenting in the plugging of the first four wells, operations have been improved and eight wells have been plugged, resulting in a saving of 10 per cent of the irrigation demand.

The Roswell artesian basin is situated in the Pecos Valley in southeastern New Mexico. The area irrigated by water derived directly or indirectly from this artesian reservoir is about 60,000 acres. Underlying the valley fill of alluvial clay and sand there are thick strata of sand and shale. Below this impervious formation at depths varying from 300 to 1,300 ft. is a series of limestone strata several hundred feet thick which is tilted up to the west and exposed on the higher elevations of the Sacramento Mountains. The other details of geological structure all provide a typical artesian basin condition of unusual size. Recharge of the artesian reservoir is derived from rain and snow falling on a catchment area of 4,000 square miles on the mountains to the west.

Artesian flow originally extended over an area of about 650 square miles. Extensive use of this underground reservoir, with expanding irrigation demand, decreased the area of artesian flow to about 500 square miles in 1916 and still further to about 425 square miles in 1925. It is estimated that the area in 1932 had not been further decreased. Production from wells in this area amounts to about 200,000 acre-ft. per year, and other surface discharges bring the total to about 250,000 acre-ft. Aquifer pressures vary from 50 to 600 lb. per sq.in., with a general average surface pressure of about 10 lb.

Studies of the artesian basin as a cooperative investigation between the U. S. Geological Survey and the state engineer's office were begun in 1925. This work has been under the direction of A. G. Fidler and S. Spencer Nye, of the U. S. Geological Survey. One of the most important results of the study was the discovery that many old abandoned wells in the basin were permitting the artesian supply to leak into the upper strata. This wasting of the valuable water supply and the usual practice of drilling new wells without regard to the shutting off of the old wells led to state action for conservation.

New Mexico law, which places artesian basins under the jurisdiction of the state, was outlined briefly in *Engineering News-Record*, March 3, 1932, p. 325. In addition to careful control over permits for new water rights in the area, a further regulation, resulting from the authority provided by the act, has been the requirement that existing wells upon any acreage have to be repaired or plugged before permits are granted for drilling new wells. Continuation of this policy, together with the plugging of many of the old abandoned wells in the area, provides the basis for the conservation program.

The recovery in the artesian basin

during the years 1931-'32 indicates that the decline is not progressive and that recharge of the basin will be effective when combined with a proper conservation program. Among the most important results of the instituting of a conservation program has been a change in the attitude of the water users and an increasing desire to cooperate in the effective curtailing of waste.

Well plugging

Basic data for the well-plugging operations were developed from the work of the Survey, which included the effective use of the deep-well current meter to explore leaky wells in the area. Studies indicated that the losss from the older wells ranged from a fraction of a second foot to a probable maximum of 5 sec.ft. per well. Such information indicated that the leaky wells presented a serious problem, and the 1931 act set aside a $20,000 fund to inaugurate a program of well-plugging. Although each well presents a separate problem and requires study to effect the best means for preventing waste, the general steps of the process can be outlined briefly.

Prior to the present program some efforts at well-plugging had been attempted in the valley, and two wells were successfully sealed by the use of fluid mud in 1928. The principle of this method is to pump into the well a mixture of clay and water (1.5 sp.gr.) until the hole is completely filled. The clay settles rapidly from this liquid, the water above the precipitating clay is replaced by more fluid mud, and the operation is repeated until the well is filled by the plastic clay, having a sp.gr. of about 2.0. This column of plastic clay produces a hydrostatic pressure in the aquifers, sealing the pores in the strata and closing off the well. Various problems involved in the operation of this method, its effectivenes against a well with high artesian pressure and the permanence of the clay seal led to an investigation of improving the operations with the use of portland cement.

The use of the portland cement plug requires the placing of cement in sufficient quantity at the proper elevation in the well and the exertion of sufficient pressure to force the plug against the walls of the well to prevent the upward escape of water. Little information was available on the subject at the start of the work. Oil-well plugging operations, while very successful, are too expensive for economic plugging of artesian wells. Experiments were undertaken using sheet-metal wells 8 in. in diameter and 20 ft. long. These experimental units placed upright on the ground were equipped with overflow valves and pressure gages at the top to simulate actual well conditions. A 2-in. tube was then inserted from the top to a point about 5 ft. above the bottom, and mud was pumped into this tube until the well was filled. Immediately a quantity of neat cement grout was pumped in followed by a final slug of mud to force the cement out of the 2-in. tube into the well casing. The studies indicated that if cement as dry as could flow through the vertical tubing were pumped into mud weighing from 13 to 14 lb. per gal., it would set within a short time, providing a solid plug capable of producing a complete seal.

This general method was enlarged upon and used effectively on the wells already plugged. In general, the procedure is as follows: A 2-in. diameter pipe is run into the well down to a point which studies indicate as the desirable location for the cement plug. Mud fluid is then pumped into the well through the tubing until the return fluid indicates a weight of about 12½ lb. per gallon. A final pumping with mud as heavy as can be handled by the pump is then run into the well to provide a temporary seal and support the cement during setting. A neat cement grout is then injected through the tubing followed by sufficient heavy mud almost to clear the tube of cement. The 2-in. tube is then withdrawn quickly, and the cement is allowed to set. Finally, after the seal has been effected, the top water is replaced with mud until the well is completely filled with clay.

Because of conditions in the old and abandoned wells it is difficult to secure data on the condition of the hole to be plugged. The lime rock is often eroded by the action of flowing water, forming large cavities that have an indeterminate volume. Therefore, there is generally no advance information on the amount of material required to plug the well. An 8-in. well of 950-ft. depth would theoretically require 322 cu.ft., or 12 cu.yd., of material to fill it completely. Actual quantities required in the eight wells plugged have greatly exceeded this figure, the smallest quantity being 15 cu.yd. of dry clay and the largest 250 cu.yd. The average amount was 130 cu.yd. of dry clay. Twenty sacks of cement will fill about 60 ft. of 8-in. hole, but in a badly eroded well may provide a plug only 3 or 4 ft. deep. Extra cement is advisable as a precautionary measure, and from 20 to 30 sacks per well were generally used.

The cost of plugging the first eight wells averaged about $500 each, but this cost included the experimental study and much of the original equipment used. Much of this preliminary work was designed to accumulate data for a guide to future operations and to perfect methods that would be effective and economic.

Results

Measurements of water levels in the region of the plugging operations must be extended for a considerable time to determine the effectiveness of the work. However, an estimate of the loss of water from the eight wells already plugged was a continuous flow of 21½ sec.-ft. or 9,600 gal. per min. This represents about 10 per cent of the water beneficially applied in the Roswell artesian basin. Further, records of artesion water levels during the first half of 1932 indicate that they did not fall below the corresponding levels for 1931. In view of the continued decline in the water level during the preceding years, this observation is believed to represent a material conservation. The results indicate that the cost of plugging the wells is less than the value of the water saved.

The work has been carried out by Clifford G. Smith and W. M. Erviu, artesian well supervisors under the direction of Thomas M. McClure, state engineer, and George M. Neel, former state engineer.

Letters to the Editor

Up-to-Date Municipal Engineering

Sir—The work done by engineers in improving modern civilization is far from being held in universally high esteem. The following letter, recently received by the writer, makes that abundantly clear. It should be explained that the letter was signed by the town clerk, who is "also Mem. of Council & Water Board," and was in reply to a letter from me offering the services of my organization in connection with a proposed water supply.

> Dear Sirs: Your letter to hand in reference to our proposed water system.
>
> Trouble is, you are too far behind. We are the first town to get approval and working on plans and specifications by local engineers now
>
> Our project is so simple that, outside of the customary drawings, the engineers are rather a hindrance to us.
>
> The writer has made this subject a special study for 3 years, and we have lived within sight of the whole project for 125 years, and were subscribers to the *Scientific American* in 1850, so you see, a newcomer has a lot to learn to beat us.
>
> Yours truly for the present,

Perhaps our major shortcoming has been that we have subscribed too long to the wrong publication.

"CONSULTING ENGINEER."

Is the Profession Overcrowded?

Sir—Your enterprise in publishing in your issues of Oct. 12 and 19 important information for professional engineers will, I am sure, be commended by many. For some time there has been a widespread impression that the professional engineering societies have come under the influence of advisers who regard the profession as overcrowded. At a time when thousands of qualified professional engineers are still unemployed, many think that the opposite policy would have been more helpful—i. e., of maintaining that there is a lag in necessary engineering work in all fields (except perhaps in the building of central power stations, which is well ahead) and that actually the country has not enough professional engineers for its needs. A leading question suggests itself: "Is it the professional engineer or is it engineering work that needs publicizing now?"

WILLIAM E. BULLOCK,
Consulting Engineer.
New York, N. Y.,
October 23, 1933.

Soil-Study Research

Sir—Almost ten years ago your paper took upon itself the difficult task of bringing before the American engineering public some new theories in foundation engineering propounded by a then-unknown experimentalist, Charles Terzaghi. Practically every paper in recent years on foundation research and design makes contact with the fundamental principles published in those original papers. However, I am writing this letter not to be historical but to point out an amazing antithesis in two articles published in your paper.

The series on rolled fills, by R. R. Proctor, presents to the engineering public a striking confirmation of the worth of soil-mechanics research in a very important field. Both the author and your paper are to be congratulated on presenting a successful application of these principles of consolidation in the treatment of rolled fills.

With this gratifying treatment in mind, it is all the more amazing that a series of soil experiments can be executed, which ignores *in toto* all the work that has been done in foundation research. ("Soil-Bearing Tests for Columbus Water Tanks," by Prof. John C. Prior, Oct. 6, 1933.) Load tests on clay with contact surfaces 0.4 sq.ft. in area were viewed as giving authentic results for the complete design of a foundation on this soil, notwithstanding the data that have been published on consolidation of clay, the necessity of determining load distribution at depths comparable with the dimensions of the complete building area, and the consequent necessity of complete boring records to these greater depths.

If the mass of data now available to all foundation engineers is so completely ignored, one is compelled to agree with the author of the paper that the only resource left is the empirical judgment of the engineer in interpreting "small-scale" tests.

However, in view of papers like Mr. Proctor's and the large number of foundation engineers now applying in a most successful manner the tenets of the new soils mechanics, no such pessimistic view need be held.

New York, N. Y. GEORGE PAASWELL.
Oct. 27, 1933.

Book Reviews and Notes

A Monthly Commentary on Current
Additions to the Civil Engineer's Library

Aerial Cameras in Mapping

MULTIPLE LENS AERIAL CAMERAS IN MAPPING—By the Technical Staff of the Fairchild Aerial Camera Corporation. Cloth; 6x9 in.; pp. 161; photographs, diagrams and tables. Published by Fairchild Aerial Camera Corp., New York. $5.

Engineers interested in the technique of the photographic work in connection with aerial mapping will find much of value in this treatise on multiple-lens aerial cameras and their application to mapping. Those who are less concerned with the technique of the camera work, but who expect to resort to aerial methods of making maps will find the sections of the book relating to the application of the method of value, both as demonstrating the possibilities and the limitations of the method.

Borders of Zoning Districts

TRANSITION ZONING: VOL. 5, HARVARD CITY PLANNING STUDIES—By Arthur C. Comey. Cloth; 7x10 in.; pp. 150; photographs, tables and diagrams. Published by Harvard University Press, Cambridge, Mass. $2.50.

A difficult and much-neglected feature of city zoning work is the subject of this book—that of making a transition from commercial to residential districts. Too frequently the value of residential property adjoining the district boundary is destroyed or greatly reduced by the overshadowing effect of the business district. In this volume of the Harvard City Planning Studies there is given an index of cities using transition zoning, a compilation of transition clauses in zoning laws, an analysis of the more important ones, with illustrations and comments as to the best methods of securing proper transition.

Azimuth Determination Simplified

AZIMUTH DETERMINATION—By E. F. Coddington. Paper; 6x9 in.; pp. 73; tables, photographs and line drawings. Published by the Engineering Experiment Station, Ohio State University, Columbus, Ohio. 50c.

The importance of this booklet to the engineer is emphasized by William Bowie, Chief of the U.S. Coast and Geodetic Survey, in a foreword in which he states that there are few engineers who do not, at some time in their lives, need to determine the true bearing or azimuth of a line; the need often confronts the engineer suddenly and without giving him an opportunity to secure the special training required. The booklet attempts to give the engineer the fundamentals of that training. It is divided into four major parts: a discussion of the celestial sphere and methods of computing time, determination of azimuth from the sun, determination of azimuth from Polaris, and an appendix containing a number of tables necessary for these operations. These tables eliminate the need for the year booklet usually used by surveyors. No mathematics higher than trigonometry are essential to a grasp of Professor Coddington's presentation.

Stresses in Frames of Multiple Stories

Reviewed by A. Floris
Los Angeles, Calif.

DIE PRAKTISCHE BERECHNUNG DER STAHLSKELETTRAHMEN — By Georg Unold. Paper; 7x10 in.; pp. 75; line cuts. Published by Wm. Ernst and Sohn, Berlin, Germany. 7 RM.

WIND stresses in multiple-story frames usually are determined by means of approximate methods. By making certain assumptions, the frame can be analyzed by statics alone, without taking the deformation of the structure into consideration. For gravity loads, on the other hand, the frame action unfortunately is neglected in the design. Although such methods of procedure are speedy, nevertheless their accuracy leaves much to be desired. For this reason the moment distribution method developed by Hardy Cross and extended by others to cover wind stresses has found great favor among American engineers. However, in spite of its simplicity the indirectness of the method is a serious handicap for general use. Far better results can be achieved by a systematic arrangement of the elastic equations in such a way that the calculations can be carried out almost automatically. This has been done successfully by V. Lewe, P. Pasternak, F. Takabeya and others.

The author of the book under review, while proceeding along the lines laid down by Takabeya, develops a new method of greater simplicity and generality. The analysis is based on the equations of deformation, known as the slope deflection method, and consists of the skillful arrangement of these equations in tabular form. The arrangement makes it possible to solve the simultaneous equations by means of the slide rule only, using the method of iteration.

For wind pressure the slope deflection method gives two sets of equations, those due to the joints and those due to the stories. Takabeya's method involves the use of both sets of equations, while Unold appreciably reduces the number of unknowns by eliminating the last set of equations entirely. This important advantage is followed by other improvements and simplifications, as compared with Takabeya's method. They are: the use of the ratios of the moments of inertia of the members of the frame and of the ratios of their lengths, instead of their actual values. In writing down the elastic equations, the choice of succession of the joints is immaterial. This is not the case in Takabeya's method. In the latter method hinges can be introduced only at the supports of the frame, while with the author's method they can be assumed at the end of the beams.

The proposed analysis is accurate and has the advantage of being very simple. The reviewer believes that this eminently practical book will be widely used. As to the difficulty of the language, it can be stated that the tables containing the elastic equations are almost self-explanatory.

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Miscellaneous Notes on Booklets and Reprints

Insulation for House Construction; Extension Series No. 31, Engineering Extension Department, Purdue University, Lafayette, Ind. Price 25c. outside Indiana.

Report on the Mayor's Housing Commission, Milwaukee, Wis. Copies may be obtained from Charles T. Bennett, City Planning Engineer, Milwaukee, Wis.

Hydraulic Laboratory Research work in progress in this country is summarized in "Current Hydraulic Laboratory Research in the United States," Report No. 1-3, published by the Bureau of Standards, U.S. Department of Commerce, Washington, D. C.

Methods of Building Small Dams and spillways are given in "Reservoirs for Farm Use," Farmers Bulletin No. 1703, U.S. Department of Agriculture. Copies may be obtained from the Superintendent of Documents, Washington, D. C., at a price of 5 cents.

The Bibliograph of Seismology for April, May and June, 1933, published by the Dominion Observatory, Ottawa, Canada, covers much of the available printed matter on the recent California earthquake and about 100 other references to seismic disturbances and their recording. Price 25c.

A Booklet of 35 Plates of drawings, showing examples of reinforcing steel arrangement in various types of reinforced-concrete construction, has been prepared (in French) by V. L. Kouznetzoff of Prague, Czechoslovakia. The booklet is entitled "New Examples," to differentiate it from a similar book published by the same author in 1931. It is published by Dunod, 92 Rue Bonaparte, Paris, France.

Deterioration of Structures in Sea Water, the 13th (interim) report of the committee of the Institution of Civil Engineers, may be obtained from His Majesty's Stationery Office, London, for 1s. 6d. The first report of this committee was published in 1920. All of its reports except four that are out of print may also be obtained from His Majesty's Stationery Office, London. Prices on request.

Step-by-Step Procedures for oxy-acetylene welding of steel, cast iron, copper, brass and lead piping are contained in a new 160-page book published by the Linde Air Products Co., New York, N. Y. The book aims to provide all the necessary data for the satisfactory use of oxy-acetylene welding and cutting. Chapters are included on testing and qualifying welders for pipe work, on inspection methods while pipe welding is in progress, on methods of testing welded joints and on estimating costs. There is no charge for the book.

The Influence of Temperature on the strength development of concrete is treated in Technical Paper No. 14 of the British Department of Scientific and Industrial Research. The report contains the latest results of laboratory work at the Building Research Station and correlated full-scale tests. The belief is expressed that the experiments form the most complete examination of the subject yet made anywhere. Available from His Majesty's Stationery Office, London, 2s. net (above 50c.), or the British Library of Information, 270 Madison Ave., New York.

Supporting Strength of Rigid Pipe Culverts, Bulletin 112 of the Iowa Engineering Experiment Station, Ames, Iowa, is devoted to a report of an investigation conducted by the station in cooperation with the U. S. Bureau of Public Roads. It is written by M. G. Spangler. The work reported is a part of the extensive culvert researches inaugurated in 1915 by Anson Marston. The purpose of the tests recorded in Bulletin 112 was to determine for rigid pipe culverts of tile and concrete the ratio of the field-supporting strength to the three-edge bearing laboratory strength of similar pipe. This ratio, known as the load factor, is discussed in the report where a rational theory for its determination under all conditions of loading is given. Working values of the load factor, determined in accordance with the theory are proposed for a range of field conditions covering all cases likely to be encountered in practice.

Current Meters, their ratings and use are discussed in Technical Bulletin No. 3, Colorado Experiment Station, Colorado Agricultural College. The report gives the result of an investigation of the action of different types of current meters when rated under various conditions and of the accuracy of current meter measurement made by different types of current meters under various conditions, using standard methods of gaging. The tests reported were conducted for the most part on different models of the Price cup meter and the Ott propeller meter, but tests were made on several other types and some experimental meters. Copies may be obtained from the Experiment Station, Fort Collins, Colo.

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New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

AMERICA SELF-CONTAINED—By Samuel Crowther. Cloth; 6x9 in.; pp. 340. Published by Doubleday, Doran & Co. Inc., New York, N. Y.

DER MASCHINEN-UND GERÄTEPARK IM BAUBETRIEB—By E. Wolfer. Paper; 7x10 in.; pp. 108; halftones and tables. Published by Wilhelm Ernst & Sohn, Berlin, Germany. 11 RM.

INTERNATIONAL BOOK OF NAMES—By C. O. Sylvester Mawson. Cloth; 5x8 in.; pp. 308. Published by Thomas Y. Crowell Co., New York, N. Y. $2.

MITTEILUNGEN ÜBER VERSUCHE, AUSGEFÜHRT VOM OSTERR. EISEN-BETON-AUSSCHUSS—(Reports on tests executed by the Austrian Committee for Reinforced Concrete.) Papers No. 13 and 14. Paper; 6x9 in.; pp. 106; and 147 illustrations and tables. Published by the Austrian Society of Civil Engineers and Architects. (Osterreichischer Ingenieur und Architekten-Verein), Vienna, Austria. 10 RM. each.

McDONALD'S ELECTRICAL DICTIONARY—By George McDonald. Cloth; 5x8 in.; pp. 178. Published by Meador Publishing Co., Boston, Mass. $1.50.

THE NATIONAL RECOVERY PROGRAM—James D. Magee, Willard E. Atkins, Emanuel Stein. Paper; 6x9 in.; pp. 80; diagrams and tables. Published by F. S. Crofts & Co., New York, N. Y.

THE ELEMENTS OF REINFORCED CONCRETE DESIGN—By Haddon C. Adams. Cloth; 7x10 in.; pp. 168; tables and line drawings. Published by Concrete Publications, Ltd., London. 6s. net.

THE BOOK OF STAINLESS STEELS—Edited by Ernest E. Thum. Cloth; 6x9 in.; pp. 631; photographs, line drawings and tables. Published by American Society for Steel Treating, Cleveland, Ohio. $5.

TRADE ASSOCIATIONS—By W. J. Donald. Cloth; 6x9 in.; pp. 437. Published by McGraw-Hill Book Co., Inc., New York and London. $4.

VERSUCHE ZUR BESTIMMUNG DES TANGENTIALEN SOHLENWIDERSTANDES VON GEWICHTSSTAUMAUERN—By N. Kelen. Paper; 6x9 in.; pp. 42; halftones, diagrams and tables. Published by Hirschwaldsche Buchhandlung, Berlin, Germany. 4 RM.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England. Subscription price $5 per year in the United States; foreign rates on application.

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November 16, 1933 Volume 111 No. 20

A New Call on the Engineer

THE government's bold decision to devote a half billion dollars to increase of employment during the first part of the winter by means of a new agency, the Civil Works Administration, makes a new call for cooperation upon the public-works engineer. The CWA has been given $400,000,000 from the public-works fund, and it is to spend this sum, supplemented by local relief contributions, in a period of three months on an intensive employment campaign of maintenance and repair of public facilities and incidental minor construction such as sewer extension. The plan is to carry out small or scattered work that is normally done by day labor and that is not suited to handling by contract. If it is to be made effective, a vast number of small projects must be assembled quickly, since the government wants to put two million men to work in less than a month! There is obvious danger that so unprecedented a program may fail of its primary purpose to distribute a wage quickly, and that in addition great sums of money will be wasted in useless made-work, unless useful projects in adequate number are planned promptly and ably. Thus, city and county engineers and their brother officials are charged with a task of critical importance, a task of intensive planning whose outcome will determine the success of the CWA undertaking—whether it is to result in true self-respecting wage employment or is to be merely a sugar-coated dole.

Faith in the Future

DETROIT, with 200,000 men out of work, has voted to spend $87,854,000 on the construction of 20 miles of subway. The city will apply to the PWA for a loan, putting up mortgage bonds on the lines to be constructed. Further, the electors of Wayne County, in which are included Detroit and many neighboring industrial communities, voted to set up a Port of Detroit Authority with power to issue $60,000,000 of bonds for the development of the ports and harbors of the county. Despite wide unemployment and both past and present financial difficulties, the people of the Detroit region still have faith in the future.

Demonstrating Erosion Control

IN NORMAL TIMES an undertaking as ambitious as the grand demonstration enterprise embodied in the Soil Erosion Division of the Interior Department would probably be quite impossible, for the subject of soil deterioration lacks popular appeal, as it is bound to do while we have more than enough good soil to provide for the country's wants. Yet the loss is not only real, as is known to everyone who has occasion to travel through regions of the less stable soils, but it is of such impressive magnitude and bears so vitally on national existence that its prevention must be ranked among our most important conservation and improvement activities. Figures on the extent of soil loss do not always agree, but a recent official statement to the effect that more than 100,000,000 acres out of 350,000,000 have been ruined by gullying and sheet erosion is significant. It suggests that at no very distant time the country may revert to desert conditions unless something is soon done to cut down the loss. Aside from its agricultural and general public interests, erosion has immediate meaning to the engineer as the source of stream detritus and reservoir deposits, two of the greatest existing elements of trouble to the hydraulic engineer. If better cultivation practices and use of the control methods tried out in the field experiments of the Bureau of Agricultural Engineering can reduce these effects, the gain may warrant systematic expenditure of much greater amounts than the few millions devoted to the present demonstration.

Mersey River Vehicle Tunnel

CONSTRUCTION of the Mersey Tunnel at Liverpool, England, marks a radical change in vehicle tunnel design. By increasing the internal diameter from about 30 ft. (as heretofore practiced) to 44 ft., a roadway width of 36 ft. has been obtained, sufficient for four lanes of vehicles. Thus one tube is substituted for the two tubes of other four-lane vehicle tunnels, as the Holland Tunnel at New York. Tunnel-driving conditions under the Hudson and Mersey rivers are so unlike as to make direct comparison impossible, for while part of the Mersey Tunnel was shield-driven, it is entirely through rock, whereas tunnels under the Hudson must go through soft clay or silt. Cost figures, nevertheless, will be highly interesting to American engineers, if they ever become available. Other new elements of the Mersey Tunnel that will be studied with interest are the ventilating system, the cast-iron paving and the use of black glass on the side walls. To date the whole operation has been surrounded with such secrecy that it has been impossible to obtain the information that is normally available on large engineering undertakings.

A Required Definition

CLEAR DEFINITION of the requirement that local labor shall be employed in construction operations carried out with PWA funds is essential for proper planning of work, and the Public Works Administration should make a positive announcement on the matter as soon as possible. At present, various interpretations are being made of the somewhat vague statement in the public-works act. In some cases it is vigorously contended by local labor interests that only the business executives of the contractor come within the meaning of allowable imported labor. Accountants, superintendents and in fact all the work-directing employees of the contractor are declared ineligible. Obviously, this spells disruption and chaos of contract operations. It is upon the efficiency of his experienced works managers and skilled operatives that the contractor bases his prices and progress. Effective use of his fixed investment and liquid capital depends on this trained organization. Without these assets of organization and capital the contractor has nothing to sell the public-works official, and the latter gets no value from construction by contract. These facts are common knowledge to public-works engineers, and a clear interpretation by Washington officials of the local labor clause in the public-works act would give them real help in meeting the unusual contract conditions on work done under its provisions.

A Dangerous Expedient

VOTERS in Ohio last week prepared some serious future trouble for their municipal governments when they wrote into the state constitution an amendment limiting the total tax rate on real property to ten mills per dollar. Limitations like this are very appealing to those who have been seduced by the Reduce Taxes argument. But in practice they are likely to lead to the complete demoralization of governmental service. West Virginia cities are even now on the verge of collapse as a result of a similar constitutional amendment adopted last November. In several communities debt service alone requires more than the total revenue now available for all city functions. The discontinuance of police and fire protection, sanitation and similar services is not to be considered with equanimity, even if it does contribute to economy. Ohioans now face the task of raising the needed revenue from other sources, and it can safely be predicted that the new levies will be at least as unpopular as the real estate taxes now given special favor.

Construction This Winter

CONSTRUCTION this winter will have the distinction and responsibility of maintaining employment at full volume. The last of the major agencies of present-time construction, the Public Works Administration, has determined that it will require continuous work on the projects which it finances. Previously the same requirement had been announced by the Bureau of Public Roads, in charge of the $400,000,000 emergency highway program, and by the Chief of Engineers' office, in charge of river and harbor work, flood control and such special undertakings as the Fort Peck Reservoir.

This is substantial recognition not only of the urgent need of the times but also of the advance made within the past ten or fifteen years in mastering the problems of year-round construction. The old doctrine that construction is inherently seasonal has lost validity. Its groundlessness was proved by experience during the World War, and the lesson was then carried over into civil life—earliest in large building construction, but in due course also in virtually every type of field operation. Powerful and flexible earth-handling machines, crawler traction, developed skill in placing and protecting concrete at low temperatures and proper appraisal of the safeguards necessary to control the special hazards of winter work were among the factors of this advance.

Winter construction thus is possible, and its product need not be inferior in quality. But it remains true that frost, snow and mushy ground will never be as pleasant and as cheap to deal with as summer conditions. Well-planned preparation is therefore essential, and here lies the responsibility of the engineer and the constructor. Due progress and freedom from interruption depend on their skill in laying out plan and schedule, providing materials and tools and livable quarters, and planning the methods and safeguards of the operation. Bids obviously must take account of the increased cost that these provisions involve. So prepared, the contractor becomes a deciding force in the winter employment campaign on which the efforts of the nation are now centered.

Construction at a Crisis

NEVER in its history has construction been involved in so dramatic a situation as that now existing in Washington. The men who, coming together from all departments of construction, have worked in sincere cooperation for months to draw up a unified group of industry codes in obedience to the requirements of the Recovery Act are now facing a blank wall. They are still fighting hard for approval and official promulgation of the codes, but, though the codes are manifestly essential to revival of the industry's vigor, indecision and inaction on the part of the NRA are blocking all progress.

Because of this indecision, construction is at a crisis in its history. The unity of plan and action for which it has struggled during several years and which was nearly won by the energetic and conscientious work on the codes, is now becoming a more and more elusive prospect. Yet there can be no sound industry, no secure economic reorganization of the vast activities of construction, no lasting benefit to worker, planner, builder or buyer of construction, unless the field is integrated by the codes now waiting approval.

The essence of the attack made against the codes by an unrepresentative minority of labor, abetted by small local groups of employers, is the desire to prevent and disrupt unity of the industry by defeating the basic code through which the whole industry is to be placed under harmonious plan and control. The details of these attacks—which include even rumored threats of a nation-wide strike if the code is approved—are of minor importance. The outstanding fact is that the opposition is directed against industrial unification, and that the NRA is giving support and comfort to these hostile attempts by continued failure to act.

The ultimate roots of the conflict now raging around the construction code extend far beyond the construction industry. They lie in the temporizing attitude which the NRA has maintained toward labor relations from the beginning—its obscure and conflicting statements on collective bargaining, its failure to define the duties and rights of individual employer or employee. That the NRA's vacillating force of action on labor questions was leading to a crisis has long been apparent. The battle that rages around the construction codes represents the advent of this crisis.

The further course of action of the NRA on the construction codes will therefore be of significance to everyone concerned with industry control, but it will have most direct influence on the construction field itself. Early action to approve a centralized code will mean that a sound industry can be organized, one capable of secure economic existence and competent to build constructive labor and public relations. Inaction or a decision in favor of disintegration, on the other hand, is certain to bring loss to all, and to the public most of all. While waiting for the critical decision it is well that engineers and contractors everywhere should recognize their obligation to the men who are fighting for the codes and should support them in fullest measure by bringing further evidence before the NRA of the merits of the code fight.

NEWS OF THE WEEK

Ontario Undertakes Public Works To Relieve Unemployment

The Ontario government has formally announced a works program amounting to $38,000,000 undertaken with a view to alleviating the unemployment situation. Among the projects planned are highway and road construction and maintenance to the extent of $28,000,000; municipal undertakings for cities, towns and villages, $7,500,000; a new headquarters for the Ontario Hydro-Electric Commission, extensions to public hospitals, and other provincial undertakings, $2,500,000. The whole campaign is expected to give employment to 61,200 men.

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Wyoming and South Dakota Agree on Division of Water

An agreement between representatives of the states of Wyoming and South Dakota for the use of waters of the Cheyenne River was reached at Cheyenne, Wyo., Nov. 3, according to an announcement made by state engineer, Edwin W. Burritt. The agreement concedes that the state of Wyoming has prior right to the use of water in the Cheyenne River watershed in Wyoming for any and all purposes, but stipulates that none of the water shall be diverted into any other watershed.

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Cities to Get Help on PWA Applications

To help cities get PWA applications in shape 25 expert service men are being put into the field under the supervision of the American Municipal Association, according to Paul V. Betters, executive director of the association and recently appointed by Secretary Ickes as liaison man between the PWA and cities. Arrangements have recently been made for state leagues of municipalities to give legal aid and advice on PWA applications.

C. C. Ludwig has resigned as city manager of Albert Lea, Minn., to become Mr. Betters' assistant in charge of this work. Sherwood Reeder, formerly of the Citizens League, Cleveland, and recently a PWA examiner, has been released by Mr. Ickes to assist in directing the field force. Helping legislators to work out legislation to remove obstacles will be part of the job of the field force. While concentrating on PWA projects the field men are also authorized to give aid to municipalities in other matters.

Appointments for six states are as follows: Kansas, W. K. Seitz, governmental consultant, St. Joseph, Mo.; Michigan, Herbert Olson, former city engineer, Flint, Mich.; New York, Walter Stone, former mayor of Syracuse; North Dakota, Myron H. Atkinson of Bismarck, director of the League of North Dakota Municipalities; Texas, Adam Johnson, former manager of Austin; Wisconsin, Arthur Rabuck, planning engineer of Milwaukee.

Construction Code Still in Turmoil—New Hearings Asked

THE whole subject of codes for the construction industry has been opened up again for review and possibly for a second public hearing. This decision was reached last week by Division Administrator Muir, following extended discussion between the NRA Staff, representatives of the Construction League of the United States, of organized labor and of organizations within the construction industry who oppose approval of the basic code for the construction industry as it now stands.

Basic code demanded

The Construction League of the United States stands firm in its demand for a basic code covering all construction industry with supplemental codes for architects, engineers, general contractors, subcontractors and material installers. The basic code sets only one minimum wage for the whole industry, leaving minimum wages in the several branches of the industry to be set in their supplemental codes. Organized labor is opposed to this arrangement. If there is to be a basic code it demands that minimum rates be set for the various types of labor employed on construction and that the scale set by the Public Works Administration for work under its control be written into the basic code. But organized labor would scrap the basic code and set up separate codes for highway work, large building construction, heavy engineering construction, etc. In this it finds itself supported by some organizations in the building field, notably the Building Trades Employers Association of Chicago. This group and some builders in other large centers fear that adoption of a basic code for the whole industry might upset their existing agreements with labor organizations on the rate of pay and hours of work. Labor also demands equal representation on the control board for the construction industry.

Private construction checked

The Construction League stands out against the demands of labor on the grounds that rates based on PWA rates as a minimum will effectively kill all private construction except possibly some in the large centers where rates are not materially different from those proposed by labor. The League would leave the establishment of rates over and above the minimum required by law to establishment by collective bargaining locally.

In its desire to fix only a minimum rate in the basic code the League finds support in the NRA where council has ruled that the law requires and permits fixing only of minimum wages for common labor, that only where an industry like the bituminous coal industry makes a contract with labor and decides of itself to write that contract into the code does it get in. The NRA cannot impose schedules on an unorganized industry; both the industry and labor must agree and the industry voluntarily includes the scales in its codes. On this point Mr. Muir said "even if we could put in a scale it would have to be a minimum scale, and collective bargaining as now, would have to determine its application in different parts of the country. Collective bargaining is the only solution to that problem and we shall provide for that in any code that passes NRA." The NRA has ruled that labor problems shall be handled by code authorities only through committees or boards on which labor has representation equal to that of industry and that the local boards which reach the "area agreements" are to be appointed, not chosen by the industry that, therefore, union labor will be guaranteed full representation even though the region is not predominately unionized.

Area agreements are optional, not mandatory as some labor representatives have held, according to rulings by NRA.

U. S. Chamber statement

Into the controversy was injected, last week, a statement from the United States Chamber of Commerce, in relation to the construction code which pointed out a peril in the proposal of the union leaders that "there should be a nation-wide rate of wages below which no worker might be employed, the rate being the same, for example, in Montana, Arizona, Maine, most of Texas, and Wisconsin, outside of Milwaukee." President Harriman of the Chamber is quoted as saying that "Industries having no relation to construction will be interested in the new departure which is being urged in the labor pro-

New Corporation Formed to Speed Rhode Island Public Works

To obviate delays resulting from the requirement of a popular referendum before the state can assume obligations exceeding $50,000, articles of association have been filed with the secretary of state for Rhode Island establishing the Rhode Island Emergency Public Works Corporation. Members of the Emergency Public Works Commission are directors of the new organization, whose articles of association have been signed by Gov. Green, F. S. Peck, state finance commissioner, and Edward C. Brown, chairman of the House finance committee. Senator W. H. Vanderbilt, the fourth member of the commission, is absent from the state. About $1,590,000 in proposed projects have been submitted to the state commission by various departments and agencies. The corporation is designed to act in substitution for the state of Rhode Island in procuring and handling loans approved by the Emergency Public Works Commission and the PWA. Its proposed capital is one share of no-par stock to be issued to the state.

visions of the code. Communities which have been looking forward to revival of private construction, and which would find in these proposals with respect to wages, such increases that construction could not proceed, will be immediately concerned."

Construction code defended

In reply to attacks on the construction code from Wm. Green, President of the American Federation of Labor, and from M. J. McDonough, head of the building trades division of the federation, the Construction League, on Nov. 14, issued the following statement:

"The basic code makes no provision whatsoever for skilled labor, and the code wording makes this perfectly clear. Mr. McDonough is just as aware as we are that the legal department of NRA has ruled that rates for skilled workers may not be included in a code.

"The construction industry code includes provisions for area agreements on wages and hours. Mr. McDonough well knows that the code committee of the Construction League will welcome any provision for the representation of labor in the building construction industry through joint conference boards or other collective bargaining agencies, and that the decision as to such stipulations in the code rests with the legal and policy bureaus of the NRA.

"The American Federation of Labor demands representation without responsibility and has shown no willingness to cooperate to the slightest degree in procuring a construction industry code which all know is essential as a prerequisite to privately financed construction and sorely needed for the success of the PWA program.

"Mr. McDonough's demands are inconsistent with the National Industrial Recovery Act and are thrown up merely to camouflage the real position of the American Federation of Labor in this matter, to wit, in opposition to the very priniciple of the coordination of the construction industry.

"We feel that it is time to be frank in admitting that a showdown is inevitable. If the American Federation of Labor is to succeed in its efforts to disrupt the NRA and to prevent rehabilitation, the sooner we know that fact the better."

Further action on the code is expected at a meeting of the policy committee of the Construction League to be held in Washington on **Nov. 16.**

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Water Metering Urged For New York City

Universal metering for the water supply of New York City has been recommended by a special committee named by the mayor last March to investigate the problem of additional water supply. The report states that 200 m.g.d. are wasted because of leaky house plumbing and water mains. The argument is made that city-wide metering would conserve water usage to the point where the proposed new Delaware River supply would not be needed until 1950.

The report states that water sold at the meter rate now charged on metered premises shows a net profit of $31 per m.g., while water sold at the frontage rate, the dominant condition, shows a net loss of $8 per m.g.

Large PWA Program Planned By Allegheny County

A unified county-wide program of needed traffic improvements is being prepared for PWA loan application by Allegheny County, Pennsylvania. It includes projects within the city of Pittsburgh as well as outside projects. Principal items of the program are five bridges over the Allegheny, Monongahela and Youghiogheny Rivers, main highways connecting these bridges and carrying other important through traffic, reconstruction for highway traffic of the Wabash Railway bridge and tunnel from the heart of the city to the South Hills district, an important highway grade separation at the south end of the Liberty Tunnel, and an elevated highway and viaduct along the Monongahela waterfront from the Point to the Liberty Bridge. The total cost of the program is expected to reach 30 million dollars.

Projects grouped

In the early period of the federal public-works program the major projects of this group were proposed as a comprehensive scheme for construction under federal loan, but later, on the suggestion of PWA authorities, individual projects were submitted separately, with the proposal that they be constructed by the PWA and leased to the county. This method of financing the work was proposed because the county's available bond margin is not large enough to cover the cost of the program as a whole. Objection by the financing division of the PWA made this course of procedure appear unlikely to succeed, and on the advice of the state public-works advisory board the combined program is now being put in shape for approval by the PWA as a single project.

Proposed financing

To provide adequate security for the project it is proposed to place the work under a County Bridge Authority, which would issue revenue bonds to the PWA as security for the loan. Tolls would be charged on traffic over the new bridges, and also on traffic through the existing Liberty Tunnel and the Wabash bridge and tunnel when reconstructed to carry highway traffic. There is no present empowering statute in Pennsylvania under which such an authority could be established. A special session of the legislature which was called recently by the Governor is expected to take up the matter.

Toll financing opposed

Opposition to imposing toll charges on Liberty Tunnel Traffic is expected from residents in the South Hills District who use the tunnel daily in going to and from the city. As the tunnel is located on a through highway to the south, however, it provides a means for collecting a service charge from highway traffic that is considered essential to the financial soundness of the proposed revenue bond financing.

Development of the program is in charge of the Allegheny County Commissioners, with John M. Rice as Consulting Engineer and E. L. Schmidt as Director of the Planning Division and engineer of the County Planning Commission. Designs for important parts of the program within the city, especially the waterfront elevated highway, are being prepared by the public works department of Pittsburgh under Charles M. Reppert as chief engineer, in cooperation with the county authorities.

Sir Alexander Houston Resigns From London Water Board

On Oct. 6, Sir Alexander Houston, director of water examination of the Metropolitan water board, London, England, tendered his resignation to take effect the end of the current year. Sir Alexander entered the service of the board in 1905 following on the board's decision to establish a central laboratory. During the ensuing period of over 28 years the water examination department has played an important part in securing the health of the vast population supplied with water by the board. As the result of his researches many difficult problems relating to the protection of water supply sources and water purification have been solved, with advantage not only to the London water board but to other water authorities throughout the world.

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Celebrates Sixty Years' Service with Indianapolis Waterworks

In celebration of his sixtieth anniversary with the Indianapolis Water Co., Edward C. Leible, cashier and assistant treasurer of the company, was honored by a luncheon on Oct. 28. Continuous service for sixty years is believed to set a record among water supply plants in the Middle and Far West, if not in the entire country. More than 100 of Mr. Leible's company associates and a large number of Indianapolis citizens were guests. Beginning 1873 Mr. Leible has witnessed the growth of the company from one pumping station and 19 miles of mains to three stations with six auxiliary units and 659 miles of mains. In earlier years his duties covered nearly all operations of the system but for the past thirty years he has been concerned with fiscal matters.

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Better Housing Meeting Held in Chicago

A unified and nation-wide policy on housing was adopted by the newly-formed National Association for Better Housing at a two-day conference held in Chicago last week. The housing plan which the conference turned over to its governing council for action was as follows:

(1) That there be established some agency for serving as a clearing house of information among the several branches of the industry.

(2) That steps be taken at once to institute a market study of the home building field.

(3) That a special committee be promptly established to consider what steps may be taken to speed up greatly the volume of modernization and rehabilitation to be done during the coming winter.

(4) That particular attention be given to extending the type of housing project being carried out with **PWA** loans in Euclid, Ohio.

(5) That the relation of housing to community planning be emphasized and the conference recommend to the **PWA** that the function of planning itself be recognized as a public work, and as such eligible to receive grants and loans such as public works that involve physical construction.

The meeting was addressed by Robert D. Kohn, director of the Housing Division of the PWA. The governing council, consisting of a group of fifty civic, social and business leaders, was appointed to carry out the plans of the conference. J. Soule Waterfield, vice-president, Starrett Building Co., was made chairman of the governing council. Harry A. Guthrie, Chicago, is secretary.

Civil Works Administration Created To Give Employment to 4,000,000

Washington Correspondence

PUTTING 4,000,000 MEN on a $600,000,000 payroll is the Administration's forthright method of tiding the unemployed over the winter. Three million men now on the dole will receive a wage for "civil" work of a minor character in local communities. The plan also anticipates that 1,000,000 more men not now on relief rolls will be driven to seek the aid of public agencies by winter's hardships.

Federal, state and local funds will be pooled to foot the largest payroll in all history. The Public Works Administration has allotted $400,000,000. The Federal Emergency Relief Administration will put up $60,000,000 and state and local communities are counted upon to contribute $130,000,000. The total will carry the program forward for 3 months to February 15, allowing approximately $100,000,000 for equipment, tools and materials. President Roosevelt has intimated that Congress will be asked to appropriate the funds needed after that date.

Public works also to be pushed

The public works program which has been gaining headway since last July also will be pushed to provide employment on regular construction jobs during the winter. To forestall any lag that might accompany winter weather in northern states, a new unit is being organized in the Public Works Administration for the purpose of following through on projects for which allotments have been made.

Municipalities to which the PWA has agreed to make grants and loans for sewers, waterworks, school buildings and other projects will not be permitted to let actual construction work ride over until spring Contracts must be awarded and PWA will insist on inclusion of a "progress" clause requiring contractors to keep on the job.

Two million of the 4,000,000 men embraced by the new civil works program now are employed part-time on made-work for family allowances averaging less than $20 a month. Their wage will be raised immediately to about $50. By December 15, 2,000,000 more men, also heads of families in most cases, will have been added to the payroll, if the plans outlined at a conference of 500 federal, state and local officials in Washington this week are carried through without a hitch.

PWA wage rates paid

Under this program the work week will be limited to 30 hours and the regular PWA wage scale will apply.

The plan contemplates transfer of "all employable persons" from relief rolls to civil payrolls for work "bordering on but not covered in the province of the PWA," says President Roosevelt. Administrator Ickes expects no encroachment on the public works program as he believes that most of the projects that the PWA will receive have already been initiated. Such projects cannot be withdrawn and transferred to the new program. Projects submitted to the PWA that are ineligible but that might be taken care of by the Civil Works Administration will be so referred.

Fundamentally, the plan merely makes more money available for relief by releasing public works funds for this purpose. In its local aspects the work program does not differ essentially from work relief as it is understood at present. Assuming that the new plan will not tolerate pork-barrel expenditures, every project will be undertaken specifically to support the unemployed, else the work would be otherwise financed.

Federal departments to help

The "outdoor" federal agencies also will join with the states and cities in mapping out work programs. Robert W. Fechner, chief of the Civilian Conservation Corps, has been requested to take care of 500,000 men in national parks, forest, soil erosion and flood control areas. Field men of the National Park Service, the Forest Service and other federal agencies were requested to report by November 13 how many men can be employed in these widely scattered services. They will be housed so far as possible in existing structures, as the Army, in this instance, will not act as quartermaster. Such men will either be put on a subsistence basis or, if living with their families, paid the prevailing wage rate.

The civil works program will be directed by Harry L. Hopkins, Federal Emergency Relief Administrator. Administrator Ickes describes the work to be done by the local civil works divisions as the kind that now is done, if done at all, by the municipality with day labor. Towns will not be permitted to undertake with the funds put at their disposal public works projects of the character now financed by the PWA. Both Hopkins and Ickes also assert that the line will be drawn against doing work on force account that is ordinarily done by contract.

Administration decentralized

Administration will be almost completely decentralized. State relief administrators who are now, in most cases, federal officials, will have charge of the program in each state. In the community, the existing public relief agency will have charge and work programs will be mapped out with officials and engineers in charge of water and other public utilities, health and sanitation, streets, parks and playgrounds, and public institutions. The local civil works divisions will be given authority to initiate, approve or reject projects involving expenditures up to a certain amount. Approval of undertakings calling for larger expenditures will be in the hands of the state civil works administrations. The limiting amounts have not yet been set.

"The basic idea of the Civil Works Administration is to put men to work quickly," said Mr. Hopkins. "We can't get speed if hundreds of thousands of projects have to come to Washington for approval. Right now the states and communities have work relief divisions of their relief offices. These same executives will be put in charge of the civil works programs and immediately put projects under way. They will be given the necessary authority under reasonable limits. They know how much unemployment there is in their community, how many are receiving work relief and what projects of community benefit can be started. If any one in a community has a good project in mind, it should be taken up first with the local administrator. If it is larger than his discretionary powers cover, the local administrator will submit it to the state civil works administration. I expect that practically no projects will involve problems requiring the state administrators to send them to Washington for review."

The work will be confined to general improvements of, broadly, a nondescript character, although the funds made available for such work exceed by $150,000,000 the allotments made to date by the PWA for major projects. The character of the civil works is revealed by the general requirement that labor should constitute 85 per cent of the total cost. A wide variety of work "chosen for its social value" was outlined by Administrator Hopkins at this week's conference with assembled governors, mayors, relief administrators, engineers and other officials. Selected to a large extent from types of work now being done in various parts of the country, "these jobs," said Hopkins, "are for the most part, work that would not be done by regular departments of the municipal, state and federal government, or work that could not be done under the PWA."

Details of work program

The suggested work program includes the following types:

Highways: The civil works division may carry on necessary highway work which is not being done under the regular budget of the state or municipality or provided for by the Bureau of Public Roads or the PWA. Work on highways should not be merely an attempt to provide jobs. Its use has too often been a carry-over from the time when work on roads was the traditional form of poor relief.

Roadways· Reclaiming public lands for highway purposes, brush cutting, shoulders, retaining walls, curbs, grading, filling, leveling, paving, resurfacing, clearing highway obstructions, concrete and masonry construction, bridge and underpasses, sidewalks, pathways and parkways, trees, shrubbery, planting and trimming, materials for highways, quarrying and crushing stone, rock excavating, digging, dredging, piping sand and gravel for road and street work.

Traffic: Erecting, repairing, painting traffic signals and lamp posts; constructing conduits for cables for traffic and road lighting systems; erecting, repairing and painting traffic signal markers, and traffic lanes; building parking spaces, traffic circles, view cut-ons; snow removal; traffic research.

Water Supply: Projects of the civil works division on public water systems are advisable when the labor cost is a major factor of the total cost of the project. This is especially true in the improvement of watersheds, the clearing of land for reservoirs, and manual labor in connection with the laying of mains. Major projects, especially where the other-than-labor costs are greater than 15 per cent of the total cost are discouraged as coming under the domain of the PWA. 1. Watersheds—clearing, filling, cutting fire lanes, planting and trimming trees, clearing tributary stream beds, lakes; 2. Reservoirs—clearing, cleaning, building and repairing dams and dikes; 3. Waterworks—repair of plant, landscaping grounds, digging wells, and auxiliary water supply systems; 4. Distribution system—repairs and extensions.

Sanitation: Wherever possible, sanitary operations should be of a countrywide nature. Communities may make a civil works project of a survey of their sanitary condition to determine the adequacy of sanitation before beginning sanitation projects.

Parks and playgrounds: Work should be of an extraordinary character that could not be carried in the normal budget. Only such construction should be undertaken as can be used and cared for by civil works division workers still in service, determined by the normal expectancy, after the present peak of unemployment has subsided or by the regular budgeted labor supply. 1. Reclamation and repair of grounds; 2. Thoroughfare construction; 3. Recreation facilities such as pools and bathing

beaches, tennis courts, rinks, athletic fields, baseball diamonds, fireplaces, camping sites, shelters; 4. Equipment such as benches, tables, swings, drinking fountains, comfort stations, band stands, hot houses, boat houses, outdoor theaters, tool houses, garages, stables.

Land improvements: 1. Filling and leveling and clearing lots, dumps, abandoned canals and other areas, the ultimate utilization of which is unknown; 2. Flood control and waterfront improvements—retaining walls, jetties and breakwaters; erecting, repairing and painting municipal docks and wharves; dredging, filling and riprapping on rivers, streams, lakes and ponds; 3. Public monuments and historic sites—clearing, painting, repairing, marking and mapping (cf. "professional"); 4. Range improvements—building drift fences, corrals, cattle guards and dipping vats.

Utilities and structures: A great deal of extraordinary work in the repair and maintenance of public institutions can be carried on by the Civil Works Division. This includes work on airports, armories, baths, bridges, canals, cemeteries, city halls, community centers, court houses, docks, firehouses, garages, hospitals, homes for aged and indigent, libraries, lodging houses, markets, museums, orphanages, police stations, repair shops, sanitariums, schools, stables, storehouses, toolhouses, workshops. The actual projects on these properties may be in the nature of minor repairs or extensions that cannot be done under the PWA and that cannot be carried on under the depleted budget of the governmental unit: 1. Concrete work, roofing, plumbing, gas, steam, painting, plastering and stucco work, shoring, moving and wrecking old structures, salvaging; 2. Installation of fire alarms and other special equipment; 3. Servicing, cleaning, portering, sign painting, attendants and watchmen.

Plant disease and pest control: Tick eradication by dipping, poisoning and quarantining; mosquito extermination by drainage, oiling, stream clearing and other malaria control measures; rodent control by eradication of rats, prairie dogs and gophers; plant control by eradicating ragweed, poison ivy, artichoke-thistle; and other projects for controlling plant and animal diseases.

Professional: Projects to provide employment for the professional man for whom suitable work relief is seldom provided include laboratory work, such as water and soil analysis; additional inspectors to locate illegal electrical connections or water consumption; statistical surveys of a social, political or economic nature; studies to provide needed information on agriculture, traffic, sanitation, health and other conditions.

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Record Size Caisson Placed for San Francisco-Oakland Bridge

The record breaking 92x197-ft. caisson for the central anchorage of the west channel crossing of the San Francisco-Oakland bridge was floated into position Nov. 8. It was built at the Moore Dry Dock, Oakland, for the Transbay Construction Co. and towed into position by four tugs in four hours. The working dock and four stiff-leg derricks which will be used for sinking had previously been completed (*ENR* Oct. 19, 1933, p. 464).

This caisson will be sunk to rock at a depth of about 200 ft. and will form the base of the common central anchorage for the two 2,300 ft. suspension spans between San Francisco and Yerba Buena Island. When completed it will rise about 300 ft. above water line.

The caisson for Pier 6, nearest the island, is now drawing about 55 ft. of water having received its first 20-ft. lift of concrete. Concreting has now stopped while the next 20-ft. lift of steel cylinders, timber cofferdam and structural frame is added. Three more 20-ft. lifts will be required to sink this caisson to the bottom of the bay 105 ft. below water surface. This work is being done from floating equipment because of the water depth at the site.

T. Chalkley Hatton, Authority on Sewage Disposal, Killed

T. Chalkley Hatton, consulting engineer, Milwaukee, Wis., and for thirteen years chief engineer of the Milwaukee Sewerage Commission, died on Nov. 11 as the result of an automobile accident the day before. Recently he had been acting as consulting engineer of the Sewerage Commission in the planning for the enlargement of the city's sewage disposal plant.

Mr. Hatton is best known for his pioneering in the activated-sludge process of sewage disposal. After a considerable experience in the design and construction of sewerage systems in cities on the Atlantic Seaboard Mr. Hatton went to Europe to study developments in sewage treatment there. Four years later, in 1913, when Milwaukee undertook the construction of an extensive sewerage project, he was appointed chief engineer of the new Sewerage Commission. In that position he conducted the experiments that led to adoption of the activated-sludge process at Milwaukee, also to the development of a commercial fertilizer, Milorganite, from the sludge. He resigned as chief engineer in 1927 after the Milwaukee plant had been in successful operation for over a year.

Mr. Hatton was born in Avondale, Pa., in 1860 and began his active engineering career as a rodman on railroad construction in 1878. His first principal work in sanitary engineering was at Wilmington, Del., 1889 to 1900, where he had charge of a sewerage system costing $1,700,000.

Mr. Hatton took an active part in the development of the American Society for Municipal Improvements, now the American Society of Municipal Engineers, and also was active in affairs of the American Society of Civil Engineers.

◆

Maine Makes Rapid Progress On State Highway Program

Practically all of the $3,369,917 federal highway program in Maine will be completed or under contract in another month. The state held its first letting under the federal schedule on August 9, when contracts were awarded for three projects. Every week since then from one to ten projects have been awarded. Half of the funds were allocated to 36 state systems (NRH) projects, and contracts have been let for 25 of these. Awards have been made for thirteen of the 25 municipal (NRM) projects, including one being done by day labor. The secondary road schedule, amounting to $842,000, was divided among 107 projects, including five bridges. All of this secondary work, except the bridges, will be completed this fall by day labor. A full description of this work will appear in a subsequent issue. Included in the NRH and NRM schedules are ten bridges, all to be done by contract. Most of this bridge work will go over until next spring. Some heavy grading will continue on the road work throughout the winter, but for the most part the projects will be shut down during the period of extreme cold weather and heavy snows. A minimum of 40c. per hour is being paid for common labor, and a minimum of 45c. is received by skilled workers on all state highway work.

Engineering Staff Appointed for Twin City Sanitary Work

The newly-organized Minneapolis-St. Paul sanitary district has appointed C. C. Wilbur, of Minneapolis, as chief engineer. J. A. Childs, chief engineer of the old Metropolitan Drainage Commission, has been made chief sanitary engineer, and G. J. Schroephfer, principal assistant engineer of that commission, has been made assistant chief engineer.

Mr. Wilbur has been with the Minneapolis Water Department since 1923 as principal assistant engineer, and under the chief engineer designed and built the Fridley Pumping Station and Filtration Plant. From 1921 to 1922 he was an assistant engineer for the St. Paul Water Board. He is a native of Minneapolis and a graduate of Dartmouth College.

◆

Bids Taken on Excavation Work At Site of Grand Coulee Dam

The U. S. Bureau of Reclamation, on Nov. 20, will open bids at Almira, Washington, for the excavation of 2,000,000 cu.yds. of common excavation and 40,000 cu.yds of rock at the site of the Grand Coulee Dam across the Columbia River near Seaton's Ferry. F. A. Banks, Almira, is contruction engineer in charge. Diamond drilling and test work at the dam site is nearing completion.

Construction of a branch line to serve the Grand Coulee dam site is proposed in an application filed by the Northern Pacific Ry. with the Interstate Commerce Commission. The projected line is 28.5 miles long, extending from Odair to the head of the Grand Coulee. The Northern Pacific is negotiating with the Great Northern for an equal division of the cost of construction, in which event the latter road would be granted trackage rights over the Northern Pacific line between Adrian and Odair.

◆

Controller Upholds Low Bidder On New York Post Office Job

The George F. Driscoll Co., Brooklyn, N. Y., low bidder on the extension to the main post office at New York, was upheld on Nov. 9 by the Controller General in its claim that it should receive the award of the contract, despite the fact that the company had not signed the President's re-employment agreement at the time it submitted its bid. As noted in our issue of Nov. 2, p. 540, the Treasury Department was considering awarding the contract for the work to the second low bidder because the specifications for the second call for bids required that all bidders be under the NRA. Since submitting its bid, the Driscoll Co. has signed the President's re-employment agreement.

The Driscoll Co. brought injunction proceedings to prevent award of the contract to the second low bidder.

Controller General McCarl did not rule directly on the question before the court, but held that the time element was a technicality as long as the Driscoll Co. now is under the NRA.

Allotments by PWA To Nov. 12 Exceed $2,653,000,000

ALLOTMENTS from the $3,300,000,000 fund of the Public Works Administration, up to Nov. 12, amounted to $2,653,485,984, according to an announcement by Harold L. Ickes, Administrator. This includes the $400,000,000 allocated to the newly organized Civil Works Administration during the previous week. Of the total, $2,208,624,811 is for federal work and only $444,862,173 for non-federal projects. This amount covers 400 projects; applications for 1,300 more are in the PWA office in Washington. About 300 are being received each week.

Allotments of $100,000,000 or over are: Farm Credit Administration, $100,000,000; highways, $400,000,000; naval construction, $238,000,000; Civilian Conservation Corps, $321,000,000; rivers and harbors, $126,000,000.

More post offices

An additional allotment for post office buildings was made during the past week. It was for $16,678,675 for 237 buildings. The allotment brings the total for work under the supervision of the Treasury Department to $53,936,000. Structures are to be less elaborate than has been the practice in post office construction heretofore, according to the announcement. Most of the buildings are to cost under $100,000.

An allotment of $75,000 has been made to the state of Florida to complete a $250,000 reconstruction program for storm-damaged schools, $50,000 has been allotted to the reconstruction of a storm-damaged wall at the Soldiers' Home, Hampton, Va., and $13,840 has been allotted to the Weather Bureau for like work.

Irrigation project

An additional allotment of $688,000 has been made to the Office of Indian Affairs for the San Carlos irrigation project in Arizona. Originally $1,650,000 was allotted to this project. The new money is for completion of the pumping system.

Municipal projects financed

Two groups of non-federal allotments announced during the past week amounted to $24,500,000 and covered 87 projects. Details are given in an accompanying table. Large items are $1,060,000 to Massachusetts for a 4-lane highway 8½ miles long from Lincoln to Concord; $5,114,500 to West Virginia for primary and secondary roads; $1,648,753 to Montana for gravel road construction and resurfacing; and $4,600,000 to Milwaukee and $2,550,000 to Reading, Pa., for waterworks.

Grand Coulee and Bonneville

The Public Works Administration is considering setting up for the Grand Coulee and Bonneville projects federal authority similar to the Tennessee Valley Authority. Asked if legislation is necessary, Secretary Ickes said that the wide powers under NIRA may be adequate.

Allotment to the State Department of funds for rectification of Rio Grande under the treaty ratified by Mexico has been referred by PWA to a subcommittee for consideration.

Initiated as a state project, the Grand Coulee has been adopted by the PWA as a straight federal undertaking. With reference to the pending California water projects, Secretary Ickes said: "We have to be rather discriminating and bear in mind that some states have not yet had fair shares."

As the public works program is now entering the contract stage the inspection division is being organized unde the direction of William M. Steele wit an engineer inspector in each state an with a resident engineering inspector an an assistant resident engineering inspecto on all projects. Supervising engineer wil be assigned to housing projects.

Each state engineer inspector is charge with responsibility for ascertaining tha all contracts between the PWA and a borrower are complied with, and through resident inspectors with seeing that th terms of construction contracts are fulfilled.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Alameda, Idaho	L. & G.	Waterworks	300	$35,000
Steubenville, Ohio	L. & G.	Waterworks	255	105,000
Waldron, Ark.	L. & G.	Waterworks	200	51,000
Sayre, Penn.	L.	Hospital	1,600	425,000
Wasatch, Utah	L. & G.	Schools	75	9,800
Columbus, Neb.	L. & G.	Sewage	300	75,000
Hamden, Conn.	L. & G.	School	2,000	700,000
Shawnee County, Kan	L. & G.	School	350	93,500
Aurora, Mo.	L. & G.	Sewers	150	33,000
State of Utah (Amended)	L. & G.	Buildings	3,632	36,000
Elizabethtown, Ky.	L. & G.	Sewage system	750	90,000
Lexington, Ky.	L. & G.	School	420	147,595
North Adams, Mass.	L. & G.	Sewers	1,800	374,000
Sidney, Mont.	L. & G.	School building	390	88,000
Philadelphia, Pa.	L.	Library building	1,620	550,000
Enid, Okla.	G.	Court house and jail.	608	49,000
Cimarron, Kan.	L. & G.	School building	360	101,400
Cedar Rapids, Iowa	G.	School	2,000	160,000
Chickasha, Okla.	L. & G.	Dormitories	144	162,000
Clinton Co., Iowa	G.	Building	910	76,500
Kennett Square, Pa.	L. & G.	Sewage system	1,680	120,000
Waltham, Mass.	L. & G.	Building	1,680	642,000
State of Mont.	L. & G.	Highway	10,200	1,648,758
Whatcom Co., Wash.	G.	Roads	40	1,400
Ellensburg, Wash.	G.	Sewers	80	3,000
Gardner, Mass.	L. & G.	Building	300	136,000
State of Massachusetts	L. & G.	Highway	126	43,000
Redwood City, Calif.	G.	Reservoir	84	5,000
Des Moines, Iowa	G.	Roads	60	2,700
Glidden, Iowa	G.	Roads	60	2,700
North Andover, Mass.	G.	Water mains	120	4,300
Westborough, Mass.	L. & G.	Tunnel	22	6,000
Amherst, Mass.	L. & G.	Building	720	238,000
Pond Creek, Okla.	G.	Water	20	900
O'Neill, Nebraska	G.	Water	20	1,500
State of Massachusetts	L. & G.	Barracks	576	122,000
Westborough, Mass.	L. & G.	Building	880	257,000
West Hartford, Conn.	G.	Sewers	1,800	74,000
Schoolcraft Co., Mich.	G.	Roads	660	20,400
King County, Wash.	G.	School	125	8,400
Tahlequah, Okla.	G.	Buildings	360	4,500
Lawrence, Kan.	G.	Waterworks	105	4,800
Cincinnati, Ohio	G.	Roads	120	3,300
Brigham City, Utah	G.	Reservoir	55	4,200
Norfolk, Mass.	L. & G.	Building	45	19,000
Norfolk, Mass.	L. & G.	Power	160	67,000
Loveland, Colo.	G.	Waterworks	12	3,800
Westborough, Mass.	L. & G.	Building	42	17,000
State of Indiana	G.	Highway	350	19,700
Belmont, Mass.	G.	Power plant	87	16,100
Shoshone, Iowa	L.	Waterworks	360	180,000
St. Albans, W. Va	L. & G.	Bridge	1,320	410,000
Milwaukee, Wis.	L. & G.	Water plant	15,000	4,600,000
Madison, Wis.	L. & G.	Water	1,200	183,200
Columbia, S. C	L. & G.	Sewer	6,000	893,000
Culpeper, Va.	L. & G.	Power	250	170,000
Warwick, R. I.	L. & G.	School	1,080	450,000
Reading, Pa.	L. & G.	Waterworks	16,200	2,550,000
Granite Falls, N. C	L. & G.	Waterworks	135	55,000
Greenwood, S. C	L. & G.	Dam	8,800	200,000
Billings, Mont.	L. & G.	School	2,016	400,000
State of Massachusetts	L. & G.	Sewage system	150	22,000
Pekin, Ill.	L. & G.	Sewage system	1,080	216,000
Florence Co., S. C	L.	Building	480	225,000
State of Massachusetts	L. & G.	Roads	3,600	1,060,000
Limon, Colo.	L. & G.	Waterworks	138	41,000
West Concord, Mass.	L. & G.	Sprinkler system	112	35,000
Helena, Mont.	L. & G.	Building	990	300,000
Medical Lake, Wash.	G.	School	75	4,300
Boston, Mass.	L. & G.	Building	140	55,000
Watsonville, Calif.	G.	Library	80	3,700
Fallon, Nev.	L. & G.	Reservoir	400	100,000
Olathe, Colo.	L. & G.	Waterworks	156	25,000
Kearney, Neb.	G.	Water mains	7	700
North Platte, Neb.	G.	Jail building	140	12,200
Gothenburg, Neb.	G.	Water	18	800
Curtis, Neb.	G.	Reservoir	18	1,200
Ravenswood, W. Va	G.	Reservoir	46	2,200
Cincinnati, Ohio	G.	Sewer	10	400
Cincinnati, Ohio	G.	Sewer	19	700
Cincinnati, Ohio	G.	Sewer	70	2,400
State of West Virginia	L. & G.	Roads	34,000	5,114,500
State of Indiana	G.	Roads	1,200	43,000
Amherst, Mass.	L. & G.	Dormitory	688	168,400
State of Indiana	G.	Road	480	34,300
State of Indiana	G.	Road	350	27,500
State of Indiana	G.	Roads	650	51,600
		Total	135,888	$24,496,353

Voters Approve Millions in Bond Issues To Finance Public Works Construction

APPROVALS of state, county and municipal bond issues at the country-wide elections held on November 7 attained impressive totals. Most of the public-improvement issues up for approval involved application to the PWA for federal loans, many of which had already received authorization.

San Francisco projects approved

Public works bonds totaling $20,000,000 were approved by the voters of San Francisco and it is planned to put some of the resulting work out for bids within a few days. The PWA had already authorized the 30 per cent grant for these projects. The voting of the bonds completes the financing. Projects approved include:

An increase in the capacity of the water supply line from the terminus of the Hetch Hetchy Aqueduct to the city, increase in the capacity of the distribution reservoirs within the city and betterments to the distribution system, totaling $12,095,000.

Raising O'Shaughnessy Dam, the main storage of the Hetch Hetchy system, 85 ft. to increase the reservoir capacity from 206,000 to 348,500 acre feet. The increase in storage will permit continuous operation of the city's power plant and will take care of some conflicting water rights. The total for this work is $3,500,000.

Construction of two sewage disposal plants to improve sanitary conditions at municipal beaches near sewer outfalls, now closed to the public, and construction and improvement of sewers, totaling $2,625,000.

Extensions to the existing high-pressure system of fire protection. The original high-pressure system was built shortly after the fire of 1906 and will now be extended to newer districts. The total is $2,000,000.

Filling of about 25 acres to permit extension of the municipal airport for a full length runway required by the Department of Commerce, together with surfacing and lighting. The total is $260,000.

Among the bond issues which the voters turned down were: Municipal power plant, transmission and distribution system; boulevard and street improvements; municipal buildings. The total of the defeated projects was about $15,000,000.

Detroit votes bonds for subway

Detroit approved by a more than two to one vote a bond issue of $87,854,000 for the construction of a rapid transit system comprising tunnels, subways and elevated railways. The issuance of mortgage bonds secured by the property and revenues of the system was authorized, but was limited to the amount to be agreed to by the PWA. Application has been filed with the PWA for a grant of $26,000,000 and a loan of $62,000,000. The proposal adopted provides that the city of Detroit as a municipality or its taxpayers will not be called upon to pay any part of the construction or operating costs of the system. The federal financing is being asked on the basis that the proposed project falls within the classification of a self-liquidating project.

Voters in the Detroit region also authorized the creation of a Port of Detroit Authority with power to issue $60,000,000 of bonds for port of harbor development. The proposal provides for establishing the area of Wayne County as a port district, having for its boundaries the boundaries of the county. An immediate objective is the coordination of facilities for handling cargoes of lake steamships.

Sanitary improvements in Columbus

Bonds totaling $13,455,000 were approved in Columbus, Ohio. The improvements involved include a sewage disposal plant, $2,720,000; intersecting sewers, $1,429,600; relief and sanitary sewers, $3,337,600; municipal light plant extension, $824,000; city hall improvements, $358,800; garbage incinerators, $162,000; main street bridge, $400,000 and Long Street bridge, $1,080,000. The sewage plant bond approval adds a further step to the progress of the sanitary improvements in Columbus; federal authorization has already been given to a PWA loan for this project.

An interesting note in the election returns comes from the city of Van Wert, Ohio, which approved a $125,000 bond issue for the construction of a sewage plant. This community recently figured in a test case brought before the Ohio Supreme Court to test the power of the state department of health to order the construction of sanitary improvements. Van Wert had pleaded inability to construct the plant because the voters had turned down a similar bond issue last year. The court ruled that the health department's orders were mandatory nevertheless and that the city's plea was not sufficient reason for setting the order aside.

Other large approvals of bonds to finance public improvements include Reading, Pa., water works, $1,850,000; Camden, N. J., electric power plant, $10,000,000; Hartford, Conn., sewage project including treatment plant, $3,500,000; Sandusky, Ohio, municipal power plant, $1,400,000; Akron, Ohio, improvements totaling $7,450,000; Summit County, Ohio (Akron), county road improvement, $5,000,000; greater Pennsylvania, toll bridges, $10,000,000.

In addition to those mentioned in connection with San Francisco, the following large bond issues were rejected: Salt Lake City, Utah, electric power plant, $18,000,000; Youngstown, Ohio, municipal light plant, $500,000.

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Speed in Highway Construction Urged on Ten State Governors

The Administrator of Public Works, Harold L. Ickes, has sent word to the Governors of Maryland, Kansas, Indiana, Colorado, Michigan, Tennessee, Mississippi, Arkansas, Illinois and Georgia, urging them to expedite their road-building program under the Recovery Act, in order to increase employment. In these states, according to Secretary Ickes, the amount of work under contract ranges from 23.4 per cent in the State of Maryland to nothing in the State of Georgia.

In contrast to this situation, Secretary Ickes states that New York State has 67.2 per cent of its work under contract, Maine has 66.2 per cent, and Nebraska, Iowa and Montana all have over 50 per cent under contract.

Floyd A. Nagler Dies; Prominent Hydraulic Engineer

Floyd A. Nagler, professor of hydraulic engineering at the University of Iowa, Iowa City, died there on Nov. 10 of complications following appendicitis. Mr. Nagler was born in Howard City, Mich., in 1892, graduated from Michigan Agricultural College in civil engineering in 1914, and received his Ph.D. from the University of Michigan in 1917, having studied there as a graduate student in hydraulic engineering. During part of each year from 1914 to 1916 Mr. Nagler was with the Fargo Engineering Co., in charge of evaporation observations on Houghton Lake, Mich., and during the remainder of the period carried on turbine efficiency tests and served as resident engineer on construction of the Junction Dam on the Manistee River. For a considerable time between June, 1917, and September, 1920, he was office engineer with Robert E. Horton, Albany. From April, 1918, to January, 1919, he was in the Meteorological Section of the Signal Corps, U. S. Army. In September, 1922, Mr. Nagler became assistant professor of mechanics and hydraulics at the State University of Iowa, and in 1922 was made associate professor. In addition to his work there in charge of hydraulics and materials laboratories and of research work in hydraulic engineering, he served as a consulting engineer on water power and hydraulic problems.

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Storm Results in Accident to Golden Gate Bridge Pier Work

A storm sweeping in from the Pacific through the Golden Gate resulted in disabling the start of fender construction on the San Francisco pier site. The structural steel guide tower used to set the fender sections in position and the first three sections of the fender system as well as the last bent of the 1,000-ft. steel trestle itself were torn loose and wrecked. The steel work was located after the storm near the end of the pier. With the aid of submarine torches and finally some blasting it was cut into sections that could be lifted by derrick barge. It was returned to the fabricating yard for reconstruction and possible change in design. The accident will result in several weeks of delay in the progress on the pier.

Other phases of the project are progressing rapidly. The creeper has been completed and the hoisting equipment for erecting the Marin tower is starting work on the base plates and leg sections. Concreting operations continue on the two anchorages.

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Tennessee PWA Engineer Dismissed by Administrator

Harry S. Berry, public works engineer for the State of Tennessee, had his services with the Public Works Administration terminated by Administrator Ickes on Nov. 13 because Mr. Berry, in a circular letter to cities of the state, intimated that those accepting loans from the PWA would not be expected to repay them. George H. Wells, Charlotteville, Va., has been made state engineer for Tennessee in Mr. Berry's place.

Obituary

Henry F. Keyes, an architect prominent in public building work at Boston, Mass., died at the Baker Memorial Hospital in Boston on Nov. 10 at the age of 54.

Charles H. Knowles, formerly chief engineer of the Evans-Almiral Co., New York City, died recently at his home in Seattle, Wash., at the age of 45. Since 1925 Mr. Knowles has been chief mechanical engineer in the office of John Graham.

Solon J. Stone, Jr., chief engineer of the John W. Cowper Co., Inc., general contractors of Buffalo, N. Y., was killed in an automobile accident on Nov. 5. He was a graduate of the Massachusetts Institute of Technology and had been associated with the Cowper Co. for 28 years. Mr. Stone was 55 years of age.

James F. Cowhig, who was resident engineer at the west portal during the construction of the Moffat tunnel in Colorado, died Nov. 8 at Macon, Ga. He was a native of Denver and a graduate of the University of Colorado. From the Moffat tunnel he went to Greece with Ulen & Co. on the construction of the Marathon dam for a short time. For several years he was with the railroad division of the American Rolling Mills Co. at Middletown and Chicago.

William A. Thompson, who had been associated with Frederick L. Olmstead and Gifford Pinchot in the development of the Vanderbilt estate at Biltmore, N. C., died on Nov. 8 at Moira, N. Y., at the age of 89. Mr. Thompson graduated from Rensselaer Polytechnic Institute and shortly thereafter became a surveyor in railroad work. In 1887 he became chief engineer of a group of experts engaged by Mr. Vanderbilt to convert the 7,000-acre North Carolina tract from a wilderness into a country estate. The work continued for ten years. The estate is now open to the public. After the completion of this work Mr. Thompson went into the canal boat business.

◆

PWA Provisions Increase Bridge Bid 8½ Per Cent

Anticipating a PWA loan and grant, the New Hampshire Toll Bridge Commission asked for alternate bids on the superstructure of the Little Bay Bridge near Portsmouth, one under ordinary conditions and another under PWA regulations. The low bidder submitted a price of $228,050 for structural steel and bridge flooring under the normal schedule and added $19,000 or 8½ per cent under PWA rules. Contract was awarded to the low bidder, the Lackawanna Steel Corporation Co. of Buffalo, under the PWA plan. Steel involved aggregates 3,700,000 lb.

SOCIETY CALENDAR

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention, Chicago, Jan. 22-26, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, Jan. 17-20, 1934.

AMERICAN TOLL BRIDGE ASSOCIATION will hold its annual convention at Cincinnati, Ohio, Jan. 26-27.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

INDIANA SECTION, American Water Works Association, will hold its annual meeting at Fort Wayne, Ind., Dec. 6-7.

NEW YORK SECTION, American Water Works Association, will hold its next meeting in New York City on Dec. 28.

CANADIAN SECTION, American Water Works Association, will hold its annual convention at Toronto, Ont., Apri 4-6.

MISSOURI VALLEY SECTION, American Water Works Association, held its annual meeting at St. Louis on Oct. 26-28. The progress of the federal public works program was given major attention. Hugh Miller, PWA state engineer for Missouri, said that applications had been made for ten water and sewerage projects, totaling $3,200,000. The number of projects submitted is low because of the lack of an adequate Missouri revenue bond law. Such a law is now under consideration in the state legislature. Officers elected for the ensuing year are as follows: Chairman, August V. Graf; vice-chairman, George J. Keller; secretary-treasurer, Earle L. Waterman, Iowa City.

ROCKY MOUNTAIN SECTION, American Water Works Association, held its annual meeting on Oct. 24-26 at Denver, Colo. Officers elected for the coming year are H. C. McClintock, Chairman; B. V. Howe, Denver, Colo., secretary-treasurer; L. C. Osborn, national director.

CONSTRUCTION STATISTICS OF THE WEEK

A spurt in highway lettings and heavy awards by the federal government raised the contract total of the week to $36,951,000, the largest in a month. Federal contracts were the second highest of the year, made up mostly of levee, river improvement and army building projects. Highway lettings aggregated 12.7 millions. Private work was the best in five weeks, with contracts amounting to $6,359,000. Large awards of the week included highways, Missouri, $1,387,000; army buildings at Ft. Benning, Ga., $1,041,000 and at Hamilton Field, Calif., $1,020,000; apartments, Chicago, $1,569,000; dikes and revetments, Missouri River, $2,393,000; levees in Mississippi, $1,029,000; and two lock projects on the Mississippi, Lock 6, $1,112,000 and Lock 16, $1,197,000. Numerous large projects of various types are scheduled for early award.

CONTRACTS
(Thousands of Dollars)

	Weekly Nov. 1932	Average Prev. 4 Weeks	Week Nov. 16, 1933
Federal Government	$6,269	$12,066	$15,922
State and municipal	15,479	14,060	14,670
Total public	$21,748	$26,126	$30,592
Total private	3,363	4,653	6,359
Week's total	$25,111	$30,779	$36,951

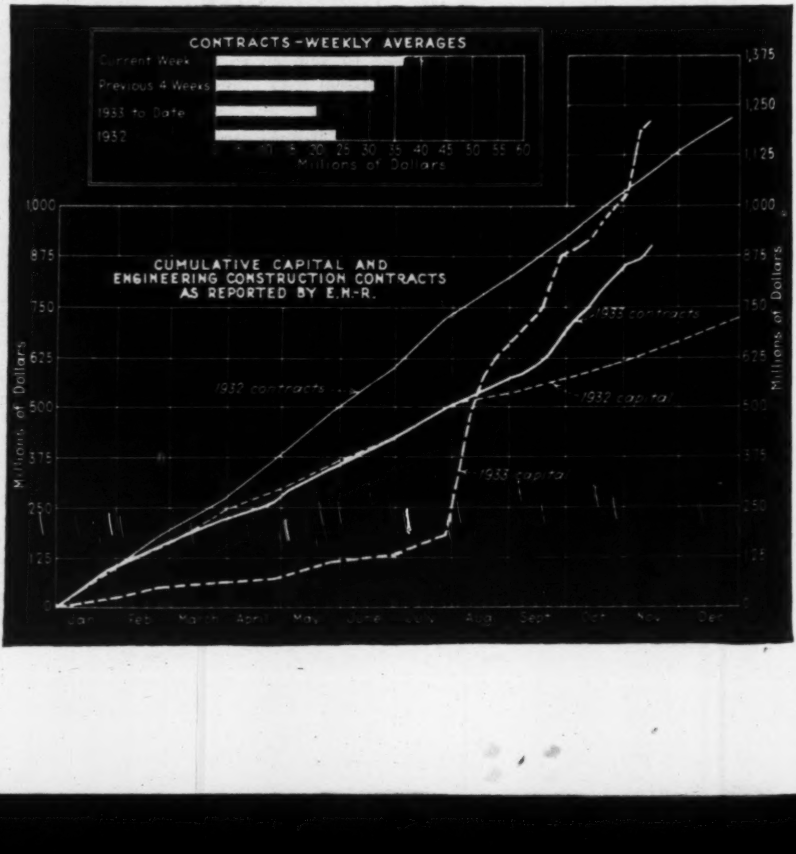
Cumulative to date:
1932.....$1,090,839 1933.....$904,698

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Week Nov. 16 1933	Cumulative 1933
State and municipal....	$274	$269,696
PWA allotments, public	24,571	708,895
Corporate issues	475	49,022
PWA allotments, private	705	185,607
Total new capital....	$26,025	$1,213,220
Cumulative, 1932..	$643,000	

Note: These figures include private bonds and stock sold for productive purposes; state and municipal bonds for construction; R.F.C. advances for self-liquidating loans; PWA loans and grants to states and municipalities, including the special highway funds; and PWA private loans.

INDEX NUMBERS

E.N.R.-Cost		E.N.R.-Volume	
November, 1933	**190.14**	**October, 1933**	**163**
October, 1933....	187.74	September, 1933..	122
November, 1932..	158.20	October, 1932.....	137
1932 (Average)...	156.97	1932 (Average)...	127
1931 (Average)...	181.35	1931 (Average)...	220
1930 (Average)...	202.35	1930 (Average)...	260
1913 (Average)............... 100